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Summer Meeting to Be Held Again at Ottawa Beach

FEW Summer Meetings have aroused such universal interest as the one planned for 1920. With the increased attendance and popularity of the meeting each year, the problem of procuring adequate accommodations for the members is not a small one. Investigation of many summer resorts from the standpoint of suitable hotel capacity, together with appropriate facilities for recreation and sports and equipment for conducting a successful meeting along the broadest lines possible, resulted in a decision to hold the coming Summer Meeting of the Society at Ottawa Beach, Mich. The dates of the meeting are June 21 to 25.

The members who attended the very successful Summer Meeting of last year are aware of the excellent opportunities at Ottawa Beach for the conferences of the Standards Committee, the presentation and consideration of papers at the professional sessions, and facilities for sports and entertainment of great variety. There is no doubt that Ottawa Beach is a very attractive place. All other places considered by the Meetings Committee lack some of the essential features available at Ottawa Beach, including geographical location, hotel equipment and service.

Professional Sessions and Standards Committee Meeting

The extensive plans for the meeting include a program of 5 days, each devoted to an important phase of automotive engineering. Too great stress cannot be laid on the importance of the Standards Committee work in which every automotive engineer should feel a responsibility. It is expected that the Summer Meeting will add new life and interest to this very important Society activity and be productive of even greater effectiveness than that evident last year. The meeting starts on the morning of June 21 with the Standards Committee session at which reports by various Divisions will be considered and passed upon. Each morning of the next 4 days will be devoted to professional sessions dealing with four vitally important phases of automotive engineering, as follows:

June 22	Tuesday	Fuel
June 23	Wednesday	Transportation
June 24	Thursday	Farm Power
June 25	Friday	Production

There has never been in the history of the Society a better opportunity for cooperative work than in this period of reconstruction, teeming with all sorts of possibilities for the progressive engineer. The program of the professional sessions has been arranged to afford ample opportunity to the members of getting together for full and free discussion of fundamental pressing problems.

The Fuel Session will be the occasion of the expression of the latest thought on engine combustion engineering. The Transportation Session is very timely now that the demand for automotive equipment to supplement the inadequate railroad and interurban service is assuming large proportions. Not only will rural express, interterminal and other forms of land motor-vehicle operation be discussed, but transportation in the air and on the water will receive consideration. Normal expansion and growth of transportation, together with increased knowledge of proper operating conditions for automotive vehicles of all character, have produced a condition such that members of the Society must be in a position to give information and instruction relative to transportation matters.

The Farm Power Session opens for discussion a field of remarkable scope. Papers to be presented at this session are certain to be of great importance to the whole membership. Inasmuch as much of automotive equipment is going into the hands of people on the farm, a thorough knowledge of the farmers' problems would better permit of that advice so necessary to the purchasers of machinery if the best results from power utilization are to be obtained. The engineering problems confronting the power machinery manufacturer will receive adequate treatment in the various papers to be presented at this session. The Production Session will apprise the members of the better production methods in use in automotive manufacturing plants. Proper inter-company conferences would net the whole industry much freedom from lost time and energy. The session will include several excellent papers covering the main underlying principles of production methods.

Hotel Accommodations

Hotel accommodations for the members at the Summer Meeting will be excellent. Exclusive use of the spacious Ottawa Beach Hotel and Waukazoo Inn has been ob-

tained, accommodating in all over 800 members and guests. The Ottawa Beach Hotel has 265 rooms and will accommodate 652 people. The quiet and restful character of this hotel affords excellent sleeping accommodations; there is ample opportunity in its parlors, halls and verandas for games, entertainments, meetings and dances which form such an essential part of a successful summer meeting.

Waukazoo Inn on Black Lake, a 15-min. boat trip from Ottawa Beach, is a retreat at which the members can be assured of the same high-grade service and accommodations as at the large hotel. This inn will accommodate over 150 people. Ferry service of twice the frequency of last year has been arranged for.

The Ottawa Beach Hotel is one of the best summer hotels on Lake Michigan. It is situated at the junction of Black Lake with Lake Michigan. The hotel is 6 miles from Holland, Mich. It fronts on Black Lake and commands a broad view of Lake Michigan. The hotel is surrounded by spacious, well-kept lawns and is one of the most attractive places on Lake Michigan. The tennis courts are adjacent to the hotel. There is an excellent sand bathing beach on Lake Michigan connected by boardwalk with the hotel. The nine-hole golf course is 5 min. from the hotel.

Sports and Recreation Program

Over 200 prizes will be given in the sports program which will be conducted on Tuesday, Wednesday and Thursday afternoons. Tennis, golf, baseball, trap shooting, races, water and special sports will be staged. Experts in amateur sports will have charge of the work. A complete booklet on the program of sports will be issued well in advance so that members can go prepared for all forms of competition.

On Thursday evening, June 24, the grand ball, including dancing contests, will be held. Every evening, except Monday, there will be dancing in the ballroom after 9 p.m.

Immediately after dinner on every evening there will be a short lecture by an authority on a popular subject of instructive value.

An improved highway system extends practically to the hotel. Ottawa Beach can be reached direct from Chicago by the boats of the Graham & Morton Line, by the Pere Marquette Railroad to Holland, Mich., or by Michigan Central, Pere Marquette, Grand Trunk, Lake Shore or Grand Rapids & Indiana Railroads to Grand Rapids, Mich., and thence by electric railway running through Holland to the Interurban Pier at Macatawa, from which a short ferry operates to Ottawa Beach.

ADDRESSES OF MEMBERS DESIRED

THE correct address of each of the members listed below is desired. In each case the last known business connection or mail address is given, but communications sent to these addresses have been returned to the New York office of the Society.

Any information concerning the present whereabouts of these members that can be furnished to the secretary with a view to communicating with them, either directly or indirectly, in an effort to bring the respective membership lists up to date, will be a favor conferred upon the Society.

Allerton, Reuben, sales manager, Allerton Engineering Corporation, 30 Church Street, *New York City*.

Bardo, J. B., production superintendent, Chalmers Motor Co., Detroit, Mich., (mail) 440 Second Street, South, *St. Petersburg, Fla.*

Barker, George R., 2434 Thor Ave., *Racine, Wis.*

Bonney, W. L., general manager, Alexandria Aircraft Corporation, *Alexandria, Va.*

Buck, Irving A., traveling sales engineer, Dodge Brothers, *Detroit, Mich.*

Chadbourn, H. N., Jr., Section 21, American Red Cross, Milan, Italy, (mail) 809 Douglas Avenue, *Minneapolis, Minn.*

Clemens, Chester E., mechanical engineer, Standard Parts Co., *Cleveland, Ohio.*

Crider, J. H., designer, Nash Motors Co., Kenosha, Wis., (mail) 757 Thirty-fifth Street, *Milwaukee, Wis.*

Crow, Harold I., aeronautical mechanical engineer, production engineering department, Bureau of Aircraft Production, 517 Air Building, *Dayton, Ohio.*

Eggen, Oscar E., private, 337th Field Artillery, Camp Dodge, Iowa, (mail) 872 Eighteenth Avenue, Southeast, *Minneapolis, Minn.*

Fay, Thomas J., manager, Rockefeller Motor Co., *Cleveland, Ohio*, (mail) 2279 Clarkwood Road.

Findeisen, Raymond, assistant in production department, Benecke & Kropf Mfg. Co., Chicago, Ill., (mail) 3101 Harlem Avenue, *Berwyn, Ill.*

Forsbloom, Victor I., chief of technical department, Aksai Co., *Rostov-on-Don, Russia.*

Goldman, Louis J., district sales manager, Monroe Motor Co., Pontiac, Mich. (mail) Colonial Hotel, Eighty-first Street and Columbus Avenue, *New York City.*

Green, L. P., factory manager, Cleveland Knife & Forge Co., 1960 West 114th Street, *Cleveland Ohio.*

Harding, Herbert P., sales manager and engineer, Standard Steel Corporation, 29 South LaSalle Street, *Chicago, Ill.*

Hoyt, Lieut. Francis R., aviation section, Signal Corps, *France.*

Jeffrey, Capt. Max L., military truck production section, Quartermaster Corps, Washington, (mail) 1836 Euclid Avenue, *Cleveland, Ohio.*

Kain, Peter, manager Detroit sales office, Philadelphia Storage Battery Co., Philadelphia, Pa., (mail) 205 Kresge Building, *Detroit, Mich.*

Kershaw, G. D., vice-president, Advance-Rumely Co., Inc., *Laporte, Ind.*

Kirkpatrick, First-Lieut. Andrew, Motor Transport Corps Training School, Camp Holabird, *Baltimore, Md.*

Knauer, C. H., 161st Depot Brigade, Camp Grant, Ill., (mail) 84 Washington Street, *Oshkosh, Wis.*

Lathrop, Thomas L., body engineer, Dort Motor Car Co., *Flint, Mich.*, (mail) 1402 Mason Street.

Liddle, Frank E., general superintendent, Adams Axle Co., *Findlay, Ohio.*

Miller, James A., president and mechanical engineer, Miller Metalwork Co., *Jersey City, N. J.*

Mills, Capt. Marshall F., aviation section, Signal Corps, France, (mail) Louis Burghardt-Mills Co., Inc., 211 West Eighty-second Street, *New York City.*

Monroe, Robert F., president and general manager, Monroe Motor Co., *Pontiac, Mich.*

Morriss, Ensign Percy G. B., Naval Flying Corps, Great Lakes Naval Station, Great Lakes, Ill., (mail) Bud Morriss Airplane School, Inc., 3511 Lincoln Avenue, *Chicago, Ill.*

Oeschger, Walter I., manager and sales engineer, Retlaw Mfg. Co.; Retlaw Chemical Process Co., Detroit, Mich., (mail) 35 Monterey, *Highland Park, Mich.*

Osburn, Harry G., 193 Englewood Avenue, *Detroit, Mich.*

Overlock, R. F., Company 102, Aviation Regiment, Naval Operating Base, *Hampton Roads, Va.*

Paine, Capt. C. L., Seventh Mobile Ordnance Repair Shop, A. E. F., *France.*

Pechnick, Frank J., chauffeur, Thirty-first Balloon Company, West Point, Ky., (mail) Pathfinder Co., *Indianapolis, Ind.*

Pfander, W. F., chief engineer, Allen Motor Company, *Fostoria, Ohio*, (mail) Vine and Fremont Streets.

Power, Donald M., designing and consulting engineer, D. M. Power, Inc., 43 St. Aubin Avenue, *Detroit, Mich.*

Roberts, David Stewart, inspector of airplanes for Signal Corps, c/o Sturtevant Aeroplane Co., Boston, Mass., (mail) 756 Kensington Avenue, *Plainfield, N. J.*

Sherwood, George W., 114 Strongs Avenue, *Stevens Point, Wis.*

Stuck, Everett, 178 Beverly Road, *Syracuse, N. Y.*

Thiesen, Alex. J., chief officer, American Red Cross Service, A. E. F., 4 Rue de L. Elysee, *Paris, France.*

Tucker, Gordon E., *Great Neck, N. Y.*

Twachtman, Capt. Quentin G., Bureau of Aircraft Production, Pomilio Brothers Corporation, *Indianapolis, Ind.*

Walton, Harold E., Eighty-fourth Aero Squadron, Kelly Field, South San Antonio, Texas, (mail) Electric House, *East Lansing, Mich.*

Wild, C. M., factory manager, American Bosch Magneto Corporation, *Springfield, Mass.*

Williams, Harrie Russell, general manager and chief engineer, A. J. Picard & Co., 9 West Sixty-first Street, *New York City.*

Wodehouse, Sergeant B. A., Second Infantry Company, Officers Training School, Camp Custer, *Battle Creek, Mich.*

Presidential Address of Charles M. Manly

WHEN you honored me with the election to the presidency of our Society at the beginning of the present administrative year, I expressed my appreciation of your confidence. I, however, told you at that time that while I would serve to the best of my ability, I must remind you that the success to be achieved would be measured almost entirely by the extent of the cooperation given me by the membership, the Council and the office staff of the Society.

I must now thank you for the most thoroughly cooperative assistance which has been rendered by the membership and I must exercise my privilege of bringing to your attention the real appreciation which you should feel for the earnest and efficient services which the members of your governing Council have performed in guiding the operations of the Society's affairs.

I feel that I would not be fair, either to myself or to the governing Council were I not to call to your attention how fortunate we have been in having so capable and devoted a general manager as we have had, who has not only maintained a virile business organization, but also contributed very largely to the maintenance of a continuing policy of advancement of the work of the Society.

I must also pay especial tribute to the valuable work performed for the Society by the Meetings Committee, the Membership Committee, the Standards Committee and the Finance Committee.

I will not attempt to review the work of the Society in the past administrative year, for I am not an historian, and besides our very efficient JOURNAL has kept you thoroughly informed of the progress of events from month to month. Furthermore, what is past is "ancient history," and our chief concern is the immediate and future work before us. We are deeply interested in the past only insofar as the experiences from it may serve to guide us in planning for the present and future.

It is probable that there has never been a time in the history of the world when there has been a more complete disorganization of the fundamental processes of industry than has been experienced by all mankind since the close of the Great War. Just as the conduct of the war was perhaps the greatest illustration that has ever been given of the power of cooperative effort, in which personal and national selfishness was so largely buried while the prevailing public opinion was that nothing would be worth while unless the great peril was overcome, so has the year through which we have just passed been perhaps the greatest illustration of the disorganizing effect of uncertainty and indecision, including a rapid change in the standard or basis of value, accompanied by an attempt on the part of the artisans of the world to secure simultaneously a readjustment of the relative proportion to be allotted to them of the proceeds of industry.

The world seems to have acted very much as a man on a debauch. After spending billions of its accumulated wealth and millions of its man power, the people in a half-dazed, undecided way, have stood around waiting in vain for the distribution of the mythical prizes, apparently fearing that if they became too busily engaged in real work they would not get their share of the spoils of war. This manifestation of personal and group selfishness was a natural and inevitable result of the momentous disturbance of the equilibrium of the standards of value which has occurred, and was bound to occur in connection with such a tremendous expenditure of wealth and man power. From the beginning of time there has been a constant struggle of all human beings to secure each for himself a larger share of the wealth of the world; and the desire and the struggle have naturally been keener among those having a direct part in the later stages of the production of the increase in the world's wealth, than among those whose activities in connection with the creation of wealth was less direct.

Fundamentally, wealth is stored or accumulated usable work or that which can be duplicated or replaced only by work. We speak of the wealth of the world having increased from generation to generation. Aside from the change in the standard of value, this increase has been almost entirely one of the accumulated usable work, or of that which would require work to produce an equivalent, where the term "work" is taken in its broadest meaning to cover not merely physical but mental effort directed by knowledge as well. The most basic measure of value is work properly directed by knowledge. The wealth of the world has increased from generation to generation largely because knowledge has enabled a definite amount of human effort to produce an increased amount of the things fundamentally required to sustain life, and to transport these things so as to maintain the proper ratio between supply and demand. The increase in wealth has, I think, been in exact step with the increase in knowledge, for it is only through knowledge that effort can produce an increasingly greater result.

APPLICATION OF TECHNOLOGICAL KNOWLEDGE

The keystone of this knowledge, that has so directed effort as to enable it to produce this increased wealth, has been, and always will be, technological knowledge. Effort that has had no technological knowledge to direct it to a useful result has added very little to the accumulated wealth of the world. The pyramids have been cited from time immemorial as monuments to man's vanity, but to me they seem to be perhaps the greatest monuments extant to technological knowledge, in that they consumed more human effort than even the digging of the Panama Canal, and yet, through the lack of technological aim or guidance toward a useful result, they are as useless as the Desert of Sahara. Standing at the other end of the row of monuments to technological knowledge are the hydroelectric powerplants of the world, which seem to me to be the greatest illustration possible of the creation of wealth through technological knowledge, for they take energy that nature is wasting in the most profligate manner and convert it into a readily usable form of power, thereby decreasing not only the drain on the world's supply of fuel, but the human effort that would be expended in connection with transforming unmined fuel into a similar amount of power. Undoubtedly the largest portion of the world's increase in wealth has been achieved through the application of mechanical power in place of human, or animal, physical exertion. So long as mankind was confined to the physical exertion of human beings or animals to produce power, the total wealth of the world could change very little, because the surplus beyond that necessary to produce the essentials of subsistence of the men and animals producing the

power could never be very great. Perhaps as good an illustration as any of the fact that neither largeness of population nor greatness of natural resources of themselves constitute national wealth, is that of China, a nation with teeming millions of man power and wonderful deposits of coal, iron and other natural resources, which yet, owing to its lack of technological direction of its industries, is utilizing neither its man power nor its natural resources in converting these potentialities into real wealth. On the other hand, most of its more than 400,000,000 people exist on what appears to us to be the most meager allowance possible of the fundamental necessaries of life, and yet expend, in securing this, several times the amount of physical effort really necessary. Picture to yourself what a wonderful change would be wrought in these conditions, in even so short a period as 10 years, were the technological guidance of this country, or even of the at present despised Germans, concentrated for that length of time upon directing the man power of China in the development of its industries.

We naturally feel appalled in contemplating the tremendous loss of man power, the destruction of materiel and the enormous burdens of national debts which have resulted from the war, especially in the European countries most deeply involved in the colossal struggle. The situation would indeed appear almost hopeless, were it not for the ability of technological knowledge to direct human effort so that, with the aid of mechanical power, not only can the loss of man power be readily met, but the materiel can be quickly replaced and a large surplus be readily produced with which to discharge the national debts in a very short time. These results, however, absolutely cannot be produced unless and until each of the nations concerned utilizes in the fullest measure the directing power of the technological knowledge of the present day. In this work of regeneration those countries that already possess not only a large body of technologically trained men but also large, undeveloped or potential resources, will be the first to replace the lost man power with mechanical power and create and market the surplus necessary to lift the burden of debt. In those countries where there is a deficiency of technologically trained men, the first concern should be to supply this deficiency by training them, or securing trained men of other nationalities. In those countries where there is a deficiency of natural resources, it will be necessary to utilize technological training to a still greater extent to use more efficiently both the man power and the natural resources that are available. What can be done in this way was brought very forcibly to our attention by the results achieved by Germany during the war, in utilizing her body of technologically trained men to increase, far beyond what was thought possible, the supply of her man power, and to make its relatively meager natural resources yield the utmost in food, clothing and other necessary materiel. In fact, in the early stages of the war, the superior ability of Germany along technological lines was very heavily felt by the Allies, and I doubt not that had Great Britain, France and Italy had as relatively large and well-trained bodies of technical men as Germany, the war would have been won by them long before we plunged into it.

There is not the slightest doubt in my mind that, if Great Britain has really as a nation learned the great lesson of the war, that technological knowledge is the keystone of strength and wealth, and applies it not merely by utilizing her present force of technical men to the best advantage, but by greatly extending the training of her coming generations in technological knowledge, she will, with her vast experience in and facilities for commerce, not only very quickly overcome her loss of man power and wipe out her burden of debt, but also build up an accumulation of wealth that will make her previous credit balances seem insignificant. If she does not both greatly increase her force of technically trained men and utilize them in directing her industries, neither her potential wealth in her colonies, nor her experience in and facilities for commerce, will bring her in the surplus, beyond her necessities, for quickly lifting her burden of debt. Even though Germany, as the price of her wanton folly, has been saddled with a burden of indemnities that is counted as staggering, and she appears to be "hamstrung" to such an extent that many able financiers seriously question whether her ability to pay the indemnities is not being greatly jeopardized, still, it is my opinion, that unless all precedents in history are upset, and Germany is prevented from entering freely into the commerce of the world, she will, through the utilization of her technical men in directing her industries, within a few generations, have lifted her burdens of debt and begun the accumulation of a large store of national wealth.

Trend of National Affairs

While technological knowledge is being or should be used in regenerating the other nations of the earth, what is going to be, and must be, the course of affairs in our country? We already have an authoritative prediction of a shortage of not less than 5,000,000 laborers in connection with the industrial activities which must be maintained in this year of 1920, even without allowing for any such normal annual expansion of our industries as we have been accustomed to. Furthermore, it does not appear likely from present indications that the so-called laboring men will exert themselves beyond the point normally expected of them; in fact, it appears that if the laboring men exert themselves beyond 75 per cent of that normally expected of them it will be through some miraculous power operating on their moral consciousness. The answer to this must be that technological knowledge will be immediately applied to a far greater extent even than heretofore in our industries. The lack of man power must be made up by the still greater use of mechanical power in place of human effort, and still greater strides must be made in efficiently utilizing human effort where mechanical power cannot yet replace it.

Consider for a moment the conditions which exist in this country in connection with such a basic industry as the mining of coal. Every ounce of coal produced in the pit mines, which constitute the largest portion of our producing capacity, is handled at least once by manual labor, with the miner doing this work under conditions where the human effort is expended at less than 50 per cent of the efficiency possible under normal conditions. It has been stated by competent authorities that, by the use of power-operated mechanical devices already available, the cost of mining coal in the pit mines and delivering it to the surface at the mines can be readily reduced to one-fifth of the present cost. This means that by the proper utilization of technical knowledge and devices we already possess at least four-fifths of the man power now engaged in pit coal mining can be released for supplying the deficiencies existing in other industries. The objection will no doubt be raised that it is

the opposition of the miners themselves that has prevented the introduction of these devices in the mines. The answer to this is, I think, that if the devices were installed, and the men who were put to operating them were given part of the saving effected thereby, they would quickly overcome their objections, and the men who were released would very soon, through the demand for man power in other industries, be found to have gone into other work where the conditions of employment and living are superior to those now existing in the coal-mining industry.

Let us hope, however, that no attempt will be made to bring about such a change by legislation. We have today a bigger surplus of legislation than of any one thing or combination of things. What is needed is a clear, honest statement of the conditions prevailing in such industries, and an equally honest statement of the remedies to be applied, and public opinion will have a quicker effect in causing the remedy to be applied than all the legislation that can possibly be enacted.

The greatest stroke of economy that this country could effect today would be achieved if the majority of the legislators in the country could be replaced by honest, fearless and broad-minded business and professional men who could be depended upon to be free from partisanship and self-interest; even if the salary paid to each of these legislators were $25,000 a year. The "high cost of legislation" is the most expensive thing we have today. No particular group of so-called laboring men are in themselves fundamentally important, any more than any particular lot of capital is fundamentally important, for there is no industrial occupation in which we cannot, in a short time, train a group of men to work efficiently. Capital and labor are both necessary to all industries and both must have a fair return or they will not operate in that industry, and no amount of legislation can coerce them into doing so. The most expensive theatrical performances staged in this country are those of our legislators, and not only do we have to pay for them, although we fool ourselves into thinking we have not subscribed for season tickets, but the real cost of the performances has increased at a greater rate than that of any commodity.

The Automotive Field

In our own field of automotive engineering the possibilities seem almost limitless. It is still less than 20 years since the automobile operated by the internal-combustion engine came into real public use, and yet today there are more than 6,000,000 automobiles running on the public highways of this country, and the industry of manufacturing them has grown to third rank in value of product, of the great industries of the country. The horsepower of all these automobiles is more than 120,000,000, or more than 1 hp. for every man, woman and child of the nation. If this total horsepower were in large units, under the management of relatively few men, and these had to be trained specially to control it, the increase in the efficiency of human effort would be only a minute fraction of what it now is with the horsepower distributed into 6,000,000 units, each readily controllable by an operator who has no technical knowledge or training, who has only the most meager experience, and who does not even need to know the whys or wherefores of any part of the mechanism, but merely knows from experience the result of the most simple operations of the controls. With the domestic demand for automobiles today exceeding the supply to a greater extent probably than has been the case at any previous time, and with an almost limitless foreign demand beginning, and appearing likely to grow by leaps and bounds with the awakening of the nations that at present are sleeping or rioting, it would be strange indeed if the industry did not double or treble its present value of output in the coming years.

In the motor-truck division of our field we are commencing to see a real acceleration in the rate at which it is displacing animal power. It is in this division of the automotive field that I expect to see the greatest rate of growth within the next few years. It is also here that some of the engineering problems that are still to be worked out are of the greatest importance. With the railroads hampered as they are likely to be by excessive legislation, and with the cost of labor double what it was only a few years ago, more and more advantage is accruing to motor trucking in competition with the railroads. This is especially true in inter-city haulage on the score of cost, aside from the very great advantage which it gives in the decreased cost of packing, lessened damage to the goods from handling, increased speed of delivery and, above all, the certainty of prompt arrival to meet the scheduled requirements. With the several million motor trucks that will be required for this work, as well as for intra-city haulage, rural motor express, and work in connection with farming, mining and the other basic industries, the automotive engineers have yet to do a larger amount of engineering work than they have ever undertaken. This will consist in developing systems of operation and repair and the collection of data in connection therewith, so that not only will the human effort to be expended for these purposes be reduced to the minimum, but costs can be stated just as definitely in advance for these operations as they can for manufacturing. And this work, including that of transportation engineering, is beyond all question that of the automotive engineer, for it is certainly automotive, and I trust that in this Society, which has been noted for its breadth of view as to the real meaning of engineering, there is today no tendency to take a definition less broad than that one which appears to be so apt, and inscribed on the walls of this very building we are now in, reads

> Engineering, the art of organizing and directing men, and controlling forces and materials of nature for the benefit of the human race.

In the aeronautical division of automotive engineering we are entering upon the new era of the application of the machines to commercial purposes, and the problems for the automotive engineer to solve in this work are of a higher order and greater in number than in any other division of the field. In the regeneration of the finances of the world, aeronautical machines are, I feel certain, destined to play a most important part. The time limit on human life has not changed appreciably in thousands of years, and is not likely to change in thousands more. Anything, therefore, that saves time is certain to be utilized to the fullest extent possible by mankind. No other known mode of transportation can compare with aeronautical in the speed with which distance can be overcome, and for this reason, if for no other, the development of aeronautical machines in commerce is sure to increase at an unprecedentedly rapid rate. In opening up the unexplored, as well as the heretofore known inaccessible regions of the earth, so that technological knowledge can be applied to developing the ma-

terials of nature existing there and utilizing them in lifting the great burdens of the war, aeronautical machines will enable a minimum expenditure of capital and labor to convert into quick assets these potential riches that would otherwise remain dormant for several generations. The wealth created by the opening up of our "Golden West" will seem small in comparison with that which will be created by the opening up by aeronautical transportation of the at present inaccessible and unexplored regions of the earth.

In the tractor division of our field there is most important engineering work to be done before the farm can be completely, or even largely, motorized. Flexibility in structure, operation and combination of units and accessibility, ease of repair, service with full interchangeability of parts and ruggedness and durability are all problems in which important advances must be made before the power tractor can win the full confidence of the farmer. While the ideal in all mechanism is the "shark's tooth," which comprises a single moving part, still I do not think that to be successful the farm tractor has necessarily to be made with any fewer parts than other automotive vehicles. But it should have as few parts as is consistent with producing the necessary result. A horse is complicated, and so is a watch, and the farmer uses both and seems to get along well with them, for they are each suited to the work they have to do. But today the farmer's watch tells him that he cannot afford to let a given amount of work take as much time as a horse requires for it, now that labor has become as scarce and high-priced as it is.

In the motor boat field we shall assuredly see a rapid increase in the transportation of freight by power boats with the increasing use of engine-operated loading devices carried by the boats. There is also certain to be a continued increase in the size of the boats and in the amount of power which they will carry. The improvement in the thermal efficiency of the heavier-type engines for boats will undoubtedly lead to the continual replacement of the steam engine in larger and larger boats.

In the stationary gas engine field we are only scratching the surface of our opportunities. The increased cost of labor, and the uncertainty of its supply, is bound to result in an enormous extension of the stationary gas engine, enabling one man to accomplish the results heretofore produced by several. This will include not only the farmer and the building contractor, but also the forester, the excavator, the road builder and men in practically every industry where electric power is not readily available.

While we are so busily engaged on all the wonderful developments and extensions of the work of the automotive engineer to facilitate travel, trade and commerce, we must not forget that the nature and selfish ambitions of mankind have not changed to any great extent in the last thousands of years, and that they are not likely to change. We must therefore during our peaceful pursuits prepare for the next war, for there will be another and still others, and the importance of automotive engineering in connection with the wars to come will be so great that we must be as thoroughly prepared as foresight can make possible. The work of our cooperative committee which was appointed by the Council at the request of the Ordnance Department to assist its own engineers in determining plans for the complete motorization of that department, must be given the attention which it deserves. Furthermore, the military and naval side of aeronautics must be kept not only thoroughly abreast of that of the most advanced nation, but as far in the lead as possible. In the next important war not only will the first great blow be likely to come from the air, but such rapid ones, and so many of such great force, will probably be struck that the nation that is not fully prepared aeronautically for land and sea operations will be likely to go the way of the nations of the past.

Increased Society Activity

If we, as a Society, are to measure up fully to the great opportunities that lie before us for advancing the work of the automotive engineer through coordination and dissemination of information in connection with the rapid and large expansions that are sure to come in the many divisions of our field, we must utilize and expand the work of the Sections of the Society and make them living, virile branches of the main organization. In my remarks at the Summer Meeting last June I spoke of the great importance to the Society of the work of the Sections, and expressed the determination to aid, in whatever way was found possible, in increasing the professional side of their activities. We have not achieved all we had hoped in this connection, for these matters move more slowly than we usually expect. We have, however, made substantial progress on the ground-work of the plan, in that we have had a very active Sections Committee that has now succeeded in reaching a unanimous decision as to the desirability of certain changes in the plan of organization of the Sections. At a recent meeting of the Council we received the unanimous report of the Sections Committee embodying these decisions, and the Council has approved various recommendations. I will not take your time in detailing them, as a full report in the matter will be given in a forthcoming issue of The Journal.

It is hardly necessary for me to refer to the importance of standardization, for it probably constitutes the biggest division of the work of the Society, and I think that practically every member is fully "sold" on the importance of it and fully aware of the substantial results that the various Divisions of the Standards Committee have been accomplishing. The most important thing in this work is to keep it up-to-date and keep it "sold" to the manufacturer and the user. In this connection I am pleased to be able to state that at a meeting of our Council this month definite steps were taken to arrange for our admission to full active membership in the recently created American Engineering Standards Committee on the same basis as the five other National Societies which are now represented on the committee. I will not attempt to explain now the aim, scope or plan of organization of the American Engineering Standards Committee, as The Journal will give you full information regarding these points, as well as the history of the formation of the committee and a full statement of the care we have exercised in making sure that we should enter fully into the activities of this national movement. Suffice it to say that our membership in this body will not only in no way interfere with the work of our own Standards Committee nor decrease in any way the prestige which has come to us from our accomplishments in this work, but our importance and prestige will be increased if we continue the quality and pace that we have heretofore achieved.

And this leads me to what I consider perhaps the

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The Officers of the Society

AT the Annual Meeting of the Society held last January a President, a First Vice-president, five Second Vice-presidents and three Councilors were elected and the Treasurer was reelected. These officers, together with the three Councilors elected at the 1919 Annual Meeting, constitute the voting members of the Council.

J. G. Vincent

President Vincent was born at Charleston, Ark., Feb. 10, 1880. His education was received at a country school near Pana, Ill., and the Cote Brillinte Grammar School in St. Louis. At the age of 17 he left his father's farm and entered the service of Smith Vincent & Co., a firm of commission merchants of St. Louis. His natural inclination toward mechanics led him to a local machine shop where he worked as a machinist's helper by day; attending night school and pursuing a correspondence course in engineering at the same time. He became a machinist and afterward a toolmaker, joining the forces of the Universal Adding Machine Co., St. Louis, in that capacity in 1902. After a few months he was given charge of the toolmaking department. In 1903 he became connected with the Burroughs Adding Machine Co., which at that time was located in St. Louis. Shortly afterward this company's plant was moved to Detroit, and Mr. Vincent was promoted to the position of superintendent of inventions. He organized and had charge of a large inventions department, in which most of the improvements on the Burroughs adding machine were conceived or made practical.

In 1910 Mr. Vincent became chief engineer of the Hudson Motor Car Co. Since 1912 he has been associated with the Packard Motor Car Co. as chief engineer and vice-president in charge of engineering, except that for about two years he was engaged in Government work in connection with the development of the Liberty aircraft engine. Mr. Vincent's work on the design of passenger cars for the Packard company had led him to make an exhaustive study of the airplane type of engine in 1915-1916 and the early part of 1917. His service in the activities involved in the design and production of the Liberty engine is well known to the members of the Society and the automotive industry. In a paper presented by him at the 1918 Annual Meeting of the Society the theory and logic of the Liberty engine program were explained, and at the 1919 Annual Meeting he gave an historical account of the development and achievement of the engine.

Mr. Vincent held a commission in the Army as colonel, devoting his attention to the Air Service until the latter part of 1918. He was successively in charge of the engine design section of the Equipment Division and the airplane engineering department of that Division, which had the duty of passing on designs of aircraft engines as well as on airplanes and airplane equipment; this Division becoming later the airplane engineering division of the Bureau of Aircraft Production. On Jan. 1, 1919, Mr. Vincent returned to Detroit to take up his duties with the Packard Motor Car Co. as vice-president in charge of engineering.

J. G. Utz

First Vice-president Utz was born at Marshalltown, Iowa, March 4, 1880. He attended the Chicago Manual Training School for three years and in 1898 entered Cornell University, being graduated with the degree of mechanical engineer in 1902. For three years prior to entering Cornell he was employed by the Cleveland Machine Screw Co. Upon graduating from Cornell he entered the service of the Cleveland Automobile Co. and later was with the Berg Automobile Co., Kirk Mfg. Co. and Olds Motor Works. In 1905 he was engaged in sales work on the Pacific coast and in 1906 became connected with the Autocar Co.

In 1907 he was associated with the Thomas (Chalmers) Detroit Co., afterwards the Chalmers-Detroit Motor Co., being chief engineer when he severed connection with the company in 1912. He then accepted the position of chief engineer of the Perfection Spring Co., Cleveland, holding this for four years. From Jan. 1, to Sept. 10, 1917, Mr. Utz was supervisor of engineering with the Standard Parts Co., becoming connected with the Motor Transport Corps in the capacity of supervisor of engineering inspection on the latter date. His service with the Government terminated in September, 1918, when he resumed his former position with the Standard Parts Co. In May, 1919, he was elected a vice-president of the company.

Mr. Utz was a member of the Council in 1916 and 1917 and Chairman of the Standards Committee in the latter year.

W. G. Wall

Second Vice-president Wall, representing motor car engineering, was born Aug. 7, 1875, at Baltimore, Md. He was graduated in civil engineering course at the Virginia Military Institute in 1894; and attended the Massachusetts Institute of Technology for two years, receiving the degree of bachelor of science in electrical and mechanical engineering in 1896. He then entered the service of the Southern agency of the General Electric Co., at Charlotte, N. C.; leaving there in 1898 he became electrical and mechanical engineer for the Smith-Courtney Co., Richmond, Va. There he installed steam and electric plants on men-of-war built at the Norfolk Navy Yard and other vessels built by the William R. Trigg Shipbuilding Co. He also acted in the capacity of consulting engineer when the powerplant equipment of the first American submarine, the Plunger, was changed from steam to internal-combustion engines.

Mr. Wall built a gasoline automobile at Richmond, Va., in 1898 and has been engaged in the construction of gasoline and electric vehicles ever since. In 1900 he became associated with the newly organized National Motor Vehicle Co., Indianapolis, as mechanical engineer and designer. At the present time he is vice-president and chief engineer of the successor of this company, the National Motor Car & Vehicle Corporation.

In May, 1917, Mr. Wall entered the Army as an engineer in the Ordnance Department, being promoted to a lieutenant-colonelcy in the following year. He spent a short time overseas investigating the possibility of improvement of the motorization of larger guns, being detailed to the British and French armies. On his return to the United States he was made chief of the motor equipment section of the Ordnance Department and until the armistice was signed was engaged in designing tractor caissons and installing heavy guns on caterpillar

self-propelled mounts. An outline of the work which he accomplished in this post was given in the paper which he presented at the 1919 Annual Meeting of the Society.

Mr. Wall was elected to membership in the Society in 1906 and served as a Vice-president from 1913 to 1915.

Glenn L. Martin

Second Vice-president Martin, representing aviation engineering, was born at Maxburg, Iowa, on Jan. 17, 1886. He is one of the pioneers of aviation in America. In 1909 he began experimenting with airplanes and like many of the early fliers taught himself to fly. The following year he was a constructor and as early as 1912 began building up a strong organization. In 1916 the company bearing his name was the principal source of airplanes for the Army and at that time held the record of having built a comparatively large number of planes for the United States Government without a single serious accident to pilot or passenger.

H. C. Buffington

Second Vice-president Buffington, representing tractor engineering, was born at Minneapolis, June 24, 1881. He attended the high school of that city. From 1903 to 1909 he was engaged in experimental work chiefly on harvesting machinery with the International Harvester Co. at its various plants. When that company started in the tractor field Mr. Buffington was at the Akron, Ohio, plant of the company.

In 1909 he was engaged by the Minneapolis Steel & Machinery Co., Minneapolis, at first on transmission machinery design. This company soon afterward became interested in the tractor, not only building a line of its own with which Mr. Buffington was prominently identified, but constructing and developing machines for other interests. Mr. Buffington devoted considerable attention to the engine design. In 1919 he resigned from the company to become chief engineer of the Holt Mfg. Co., Peoria, Ill.

In 1916 Mr. Buffington with a number of others formed the Society of Tractor Engineers. When this organization was absorbed by the S. A. E. and its Minneapolis Section was formed, Mr. Buffington served as secretary and later as chairman of the Section. He has served as a member of the Standards Committee of the National Gas Engine Association and of the Tractor Division of the Standards Committee of the Society.

C. A. Criqui

Second Vice-president Criqui, representing marine engineering, was born at Buffalo, July 15, 1865. In 1902 he founded the Sterling Engine Co., Buffalo, after having been a successful contractor on heating and ventilating installations. This company marketed, it is stated, the first three-port two-cycle engine, later turning to production of the four-cycle type.

Mr. Criqui has always been a staunch advocate of research work and development. He has been prominent in the affairs of the National Association of Engine & Boat Manufacturers and served as one of its vice-presidents in 1919.

L. M. Ward

Second Vice-president Ward, representing stationary internal-combustion engineering, was born at Bristol, Wis., June 29, 1873. After completing his high school course he served as an apprentice for two years in the machine shop and toolroom of the Chicago Brass Works, Kenosha, Wis. In 1892 he entered the University of Wisconsin and was graduated in 1896 with the degree of bachelor of science. For the next five years he was engaged in mechanical sales work at Chicago.

In 1901 Mr. Ward moved to Denver and engaged in the selling of the products of the Fairbanks-Morse Co. and supervising the installation and testing of gas engine power units principally for irrigation work. Two years later he was appointed manager of the Denver branch of the Crocker-Wheeler Co. and had charge of the sale of its electrical equipment for the Rocky Mountain region. He remained with this company until 1909 when he associated himself with E. B. Sawyer of Lincoln, Neb., who was at that time engaged in the reorganization of the Cushman Motor Co., building small marine internal-combustion engines. Mr. Ward became secretary and manager of the company and has directed its operating departments in the building of farm internal-combustion engines up to the present time.

In 1914 Mr. Ward was elected a member of the executive Committee of the National Gas Engine Association and served continuously until June, 1919, when he was elected president of the association.

Charles M. Manly

Past President Manly was born at Staunton, Va., April 24, 1876, and received his early primary and academic education in South Carolina. He was graduated from Furman University, of which his father, Dr. Charles Manly, was president, in 1896, with the degree of master of mathematics and mechanical philosophy. He then took mechanical and electrical engineering courses at Cornell University, being graduated therefrom in 1898 with the degree of mechanical engineer.

When, in the spring of 1896, Professor Langley, secretary of the Smithsonian Institution, applied to Dr. R. H. Thurston to recommend some engineer to take charge of the work which he was then undertaking for the War Department in the construction of a man-carrying airplane, Mr. Manly was recommended by Doctor Thurston and took charge of this work under Professor Langley's direction on June 1, 1898. He not only had entire charge of the building of the airplane itself, but personally invented, designed, and constructed the 52-hp. five-cylinder gasoline engine which was used on this large machine, the construction of this engine being completed in 1902. It weighed 125 lb., exclusive of cooling water, radiator and tanks, or at the rate of 2.2 lb. per hp. for the 52 hp., which it developed for 10 hr. continuously on a water absorption dynamometer. This was the first aviation engine in the world, as well as the first steel cylinder aviation engine.

Mr. Manly also had charge of all the research work that Professor Langley carried on in the development of the airplane, including the first systematic tests ever made in determining the laws of the aerial screw propeller and the tests on the supporting power of curved surfaces and equilibrium control. Mr. Manly personally piloted the large Langley airplane during the tests made of it on Oct. 7 and Dec. 8, 1903, when it was in each case so damaged by catching on the launching gear that it was impossible to get a fair test of its ability when it got into the air.

After 1903 Mr. Manly devoted his time to developing some of his own inventions in power transmission, moving to New York in July 1905. In 1915 he was consulting engineer to the British War Office, in connection with airplanes being built in this country, especially superintending the construction of the large 500-hp. twin-engine

J. G. VINCENT

W. G. WALL

J. G. UTZ

G. L. MARTIN

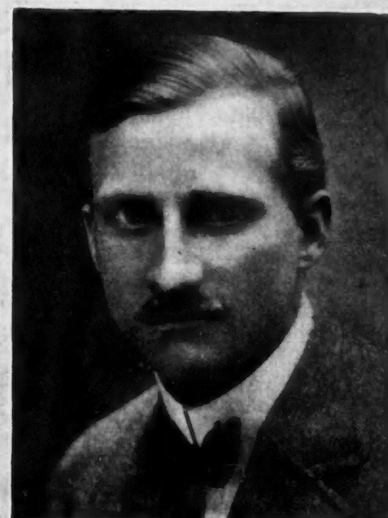
CHARLES M. MANLY

H. C. BUFFINGTON

C. A. CRIQUI

L. M. WARD

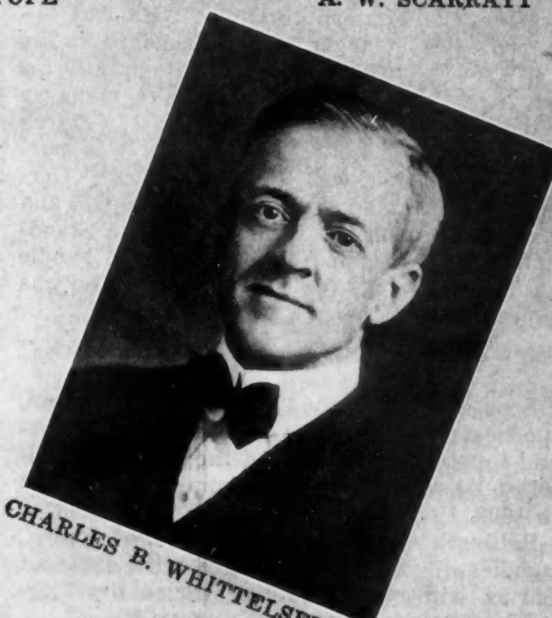
F. M. GERMANE



N. B. POPE

A. W. SCARRATT

COKER F. CLARKSON



CHARLES B. WHITTELSEY

E. A. DE WATERS

DAVID FERGUSSON

E. A. JOHNSTON

biplanes built at the Toronto factory of the Curtiss Aeroplane company.

From September 1915 to 1920 Mr. Manly has been consulting engineer to the Curtiss Aeroplane & Motor Corporation of Buffalo and New York City, also serving as assistant general manager for a portion of this time. At present he is engaged in consulting engineering work at New York City.

F. M. Germane

Councilor Germane was born Dec. 13, 1873, at Chicago, Ill. He attended the public schools of that city. After leaving school he engaged in the electroplating business, entering in 1893 the service of the George L. Thompson Mfg. Co., Chicago, in charge of several factory departments including the polishing and plating departments. When the company was absorbed by the American Bicycle Co. in 1895 all the bicycle parts manufacturing plants of this organization were segregated and incorporated as the Federal Mfg. Co. From 1898 to 1904 Mr. Germane was in the sales department of this company, having charge of the Eastern territory. He was appointed Western sales manager of the Standard Roller Bearing Co. in 1904 and after serving in that capacity for approximately two years was appointed sales manager and transferred to the factory at Philadelphia. In March 1917 when the Standard Roller Bearing Co. was purchased by the Marlin-Rockwell Corporation Mr. Germane was made general manager of its Philadelphia and Plainville plants, and upon the formation of the Standard Steel & Bearings, Inc., in October, 1919, to handle the manufacture of bearings for the corporation, he was made a vice-president of the new organization.

N. B. Pope

Councilor Pope was born July 17, 1879, at Thomaston, Me. He was educated at the public schools of Kennebunkport, Me., and Cambridge, Mass., and the Lawrence Scientific School of Harvard University from which he was graduated in 1902. Upon leaving college he was employed by the Pope-Robinson Automobile Co., Hyde Park, Mass., and for a number of years was engaged with different automobile firms with which he had varied drafting-room, shop and road experience.

In 1905 Mr. Pope joined the staff of *Horseless Age* and later of *Motor World*. When the Motor Trades Publishing Co. was organized in 1911, Mr. Pope became associated with it and is now managing editor of *Automobile Topics*.

Mr. Pope was elected to membership in the Society February, 1908, and has contributed a number of papers and discussions relating to fuel questions for presentation at the meetings of the Society and the Metropolitan Section. He was secretary of the Metropolitan Section for two years and a member of the Miscellaneous Division of the Standards Committee for the same length of time.

A. W. Scarratt

Councilor Scarratt was born in St. Paul on April 16, 1886. He received his early education in the public schools there. Later he was graduated from the Mechanic Arts High School of St. Paul after completing the engineering course. In 1905 he was employed by the Twin City Rapid Transit Co. as a draftsman in the mechanical engineering department where he was engaged in the design of car bodies and rolling stock of all kinds for approximately four and one-half years. He was then transferred to the power and electrical department, where his work consisted of power-house layouts and reconstruction work and sub-station design, and was later made assistant foreman at the shops of the company. While with this company he attended the University of Minnesota for three years.

In 1913 Mr. Scarratt accepted a position in the tractor engineering department of the Minneapolis Steel & Machinery Co. He has been prominently identified with the development and production of the line of tractors built by this company. He was elected to membership in the Society in 1915 and is at present vice-chairman of the Minneapolis Section.

E. A. DeWaters

Councilor DeWaters was born July 22, 1874, at Kalamazoo, Mich., and was graduated from Kalamazoo College in 1899 with the degree of bachelor of science. He received the same degree two years later from the University of Chicago and afterward had engineering training at the University of Michigan. A short time was spent in testing engines for the Thomas Motor Car Co., Buffalo. In 1903 he went with the Cadillac Motor Co., Detroit, as layout draftsman. Later he was assistant superintendent of the plant of that company, leaving there to go with the Buick Motor Co., Flint, Mich. Since that time he has been general foreman, layout man, assistant engineer and chief engineer. He was elected a Member of the Society in 1911.

David Fergusson

Councilor Fergusson was born in 1869 at Bradford, Yorkshire, England. After completing his general education he took a three-years' course in mechanical engineering in the Bradford Technical College, being graduated in 1889. After being employed as a draftsman at various plants engaged in the building of locomotives and steam and internal-combustion engines, he entered the service of the Leeds Forge Co. as a designer of pressed steel railroad stock. In 1893 he was engaged as a designer of steam and internal-combustion engines by Robey & Co., Lincoln, England. In 1897 he became chief draftsman with Pennington & Baines, London. In 1900 he came to New York, later taking a position as mechanical engineer and designer with E. C. Stearns, Syracuse, N. Y. He joined the staff of the George N. Pierce Co., Buffalo, as mechanical engineer and designer in 1901. He is now chief engineer of the Pierce-Arrow Motor Car Co., Buffalo. Mr. Fergusson was elected a Member of the Society in 1905.

E. A. Johnston

Councilor Johnston was born at Brockport, N. Y., Aug. 1, 1875. After receiving a public school education he entered the Chicago Business College. From 1890 until 1894 he was employed by the Johnston Harvester Co., Batavia, N. Y., serving in all departments including wood and metal pattern-making, blacksmithing, machine shop and foundry. In 1894 he accepted a position as pattern maker with the McCormick Harvester Co., and has been continuously employed by its successor, the International Harvester Co. and its subsidiary organizations as machinist, designer, experimental engineer, foreman, superintendent and manager of the experimental department. He now holds the last named position.

Mr. Johnston is the chairman of the Tractor Standards

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Addresses at the Annual Dinner

THE Annual Meeting terminated on the evening of Jan. 8 with a record-breaking Society dinner. The capacity of the grand ballroom of the Hotel Astor, New York City, was about reached, over 1600 members and guests being present. John Kendrick Bangs was toastmaster. Among the other speakers were J. G. Vincent, then president-elect of the Society; Charles E. Mitchell, president of the National City Co., and Major Arthur Bles of the British Army.

ADDRESS OF JOHN KENDRICK BANGS

GENTLEMEN, I am no orator, as these other Brutuses are who will follow me. I realize precisely what my position is here tonight. I have been asked to come because of my supreme ignorance upon all the subjects which interest you. I am the one speaker upon this platform tonight who is not going to bore you by talking about things that you think you know more about than the speaker does. I realize that in this difficult gathering in New York, which is always over-congested, and tonight more so than ever, I am nothing more than a sort of traffic cop to keep these intellectual cars and trucks, by whom I am surrounded, moving. I am going to tell them when to go, and if they do not stop when they should, I am going to tell them when to stop.

I have one little thought that I would like to leave in your minds. I will illustrate it by a story of something that I have seen since I saw you gentlemen last, which was almost as inspiring as any experience that has ever come into my life. I have had the rare privilege of visiting the scenes of war, not only in the darkest period of the war, but since the war was supposed to have been finished. I want to say to you that I found a truer Americanism on the other side of the Atlantic Ocean than I have found in the United States of America since I returned. In these days when timid souls are afraid of Bolshevists, when we are afraid to allow a Socialist to sit in the legislature of the State of New York alongside a Tammany official for fear that somebody will get everything that he has away from the Tammany man and that he will then begin to work again upon us, I want to tell you something which, if there is any timid-hearted man in this gathering tonight, will reassure him as to the true spirit of America.

Americanism

During my first visit to France in 1918, it was my blessed privilege to try to cheer up the American doughboy, who was face to face with the wickedest enemy that the world has ever known. I went down to the St. Mihiel front and there, one morning, after my first address, there came to me an American soldier-boy, 21 years of age, a private in the ranks, who, simply because of something that I had said that he liked the night before, offered to become my body-servant during the period of my stay there. I did not want an American soldier to be a valet of mine. Considering our respective missions on the other side of the sea, I should have felt it far more fitting for me to get down upon my knees and clean his boots, than have him do so for me. But he left me no alternative than to accept, because he took my uniform, boots, hat, underclothes, everything that I had, and disappeared with them. Even at the front I could not go out and pursue him in such a condition as he left me in. Within half an hour, he had returned with my uniform pressed and my boots polished, and for three days that boy followed me about and smilingly rendered every service that one man can render another. One of my own sons could not have been more solicitous for my welfare.

I naturally inquired about that lad and found that he had been taken by the draft, out of the very dregs of one of our Southern ports. He came from a poor home, he had never had three minutes of education, he had never known the meaning of the word "ideal," he had never known the nice distinction between the words "service" and "servitude," he had never looked upon his father's face, he had not any recollection who his mother was, and he had been a waif and a stray all his days. If this war had not broken out, his natural drift would have been into the embrace of some organized body of thieves, thugs and treasonous ruffians. If he had been in Russia, he might have been a follower of Trotzky and Lenin. The only socially discreditable thing he never could have been is one of these American college professors, of whom we have too many in our institutions of learning who, in these days of social unrest, violate the trust imposed upon them by the fathers and the mothers of immature youth, by preaching the ideal of Bolshevism. Bolshevism is not an ideal, but a program of murder, arson, loot and treason, based upon envy, hatred and malice.

The draft caught that boy; took him to an American camp; gave him the first taste of discipline he had ever known; taught him how to hold his head high; taught him why he had a right, as an American, to hold his head high; told him the meaning of the great names of America, of the unselfish devotion to high principle of George Washington, the broad fundamental democracy of Thomas Jefferson, the farseeing vision of Alexander Hamilton, the sense of brotherly love in the heart of Abraham Lincoln, and the everlasting sense of rightness in the soul of Theodore Roosevelt.

They sent him across the sea, and he came and rendered those little services to me, which meant nothing. But the thing that meant a great deal, and which I wish you would etch upon your hearts in moments of despair over American character and institutions, is this: On the morning I left him I went to his captain and said, "Captain, that boy has been perfectly splendid to me; I would like to do something for him. May I give him a little present?"

The captain replied, "Mr. Bangs, I do not want to see you do anything of the sort."

I said, "Captain, I am glad to note that you are a man of nice discrimination in the use of language; I will not let you see me."

And I did not; I took that boy off to one side and said, "Son, you have been perfectly bully to me, and I appreciate it from the bottom of my heart. You have rendered me service which I could hardly expect from one of my own sons, and I thank you for it. Just as you have made me more comfortable here, I would like to make you more comfortable when you go to Paris. Take this and when you spend it, think of me." Then I offered that boy 50 francs.

That lad, who had had no education, no home training, and did not know the difference between "service" and

"servitude," pushed my hand back and with a sweet boyish wistful smile and said, "Ah, Mr. Bangs, please do not offer me any money; I do not want to take your money." And then came this beautiful sentence, which in my estimation sums up the whole ideal of American character and American intent; he said, "Mr. Bangs, we did not come over here to make money, you know; we came over here to do things for other people." That was the spirit of the American boy in France!

I hope that the next few years will show that this is the spirit of America at home, and that men like you, all true Americans, gathering together, are resolved that they will make the United States not the servant of the world, but the service station of humanity. That is an ideal for Americans to live up to. Then will the departed gods return once more to earth, and their homes will be not upon the Parnassus of Greece but upon the high mountain peaks of our blessed country, America!

ADDRESS OF PRESIDENT-ELECT VINCENT

As I look back over the activities of the Society during the last several years, I think of the difficulties its early officers encountered. They had a great many problems. During their time there was probably very little of what we now know as real cooperation; there was relatively little sympathy with the standardization work, because then many engineers thought that it would militate against initiative on their part. I think you will all realize, if you will look back for a moment, what great results have been attained by the far-sighted policy of the officers of the Society in past years. I need cite nothing more to prove my point than the cooperation that existed throughout the automotive industry during the recent war. I think it is not unfair to us, as engineers, to take unto ourselves the credit for the remarkable cooperation that existed throughout this whole industry in this period. We all know that the automotive industry as a whole was anxious to find out what it could do, and ready to turn its factories upside down to start any work that we, as engineers, said it should do.

I am not sure just how much more difficult the task of the earlier officers was than that of those of us who are to serve now during the greatly increased activities of the Society. It is, of course, true that in electing us you conferred great honor upon us. At the same time you gave us considerable work to do. On behalf of the incoming officers I ask your full cooperation. We know we need it.

I think that everyone will now agree that the Society has done a great work in connection with the standardization of parts. This has not in any way reduced initiative. It has, in fact, left the engineer more free to bring about advances in design. We new officers are going to feel very proud if we can follow up the good work that has been carried on by our predecessors. Mr. Manly in his last presidential address outlined much important work to be done. If we can accomplish a considerable portion of that work, we will do well.

Society Growth and Work

The first thing probably that commands our consideration is maintaining the growth of the Society. The membership which is being added is of a high order. We believe that the quality of the membership is constantly improving. When the Society was first organized, it of course was an automobile engineering society. It follows naturally that all the work in connection with the automobile, or what has been called the pleasure car, is further advanced than other work. On the other hand, the truck work has been receiving very close consideration, and, as it has come right up along with the automobile, it is in splendid shape.

One of the new branches of the Society is the Aeronautic Division. You are all familiar with the state of affairs in connection with aeronautic development in this country just before the war. During the war we made great strides, very largely because we had some money to spend on aeronautics, and also because we had practically the whole world to draw upon for information. I wish some of you could have been in my shoes during the war and had the privilege of associating with the very high-grade technical men who came over here from England, France and Italy to teach us something of what they had learned during three years of war. They caught our spirit of cooperation; there was nothing we could ask them upon which they would not give us what information they could. When they first came over there was a distinct tendency among the engineers to be not quite fair with one another. I mean that the English, French and Italians each gave us good information, but they did not agree among themselves as to what should be done. They were all anxious to help, they all did help us a great deal and we can all take a great many lessons from what they told us.

We learned a great deal during the war, but not very much has been done since the armistice was signed. What are we going to do about aeronautics now? I realize that that is a very big problem. We must have an air program in this country.

There are other divisions of the Society that are moving along nicely. The Tractor Division has a great work ahead of it. All of the automotive branches can make good use of certain of the standards that have been adopted for some time for car work. Many new standards must, however, be established. We have committees working diligently on this matter.

It is one thing to criticize and another to really accomplish results. Let us all pull together during the coming year and continue our demonstration of what genuine cooperation is. I can only say that, with the rest of the new officers and those holding over, I am going to do the best I can. I hope when we come back here a year hence, we will have accomplished some results.

ADDRESS OF CHARLES E. MITCHELL

You automobile men with your American-made automobiles and American internal-combustion engines made America's name famous throughout the world by their great achievements during the war.

There was a time, not so many years ago, when the bankers of this country did not sympathize very strongly with the automobile men of the United States. We were not altogether on friendly terms. You can remember when bankers were loath to lend on a stock of automobiles on a dealer's floor. Why? Because you were producing "spring hats" that went out of style as rapidly as the seasons passed. You were revolutionizing your product season by season. Today you are not only preaching but practising standardization, that wonderful thing which Mr. Vincent pleads for you to continue, and urges you all to stand for in the coming year. Standardization has done more for the automobile industry from the standpoint of banking, credit and finance, than

A PORTION OF THE GRAND BALLROOM OF THE

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any other action which has been taken, and I bow to you as the men who have been responsible for that step.

In reading one of Ferraro's books, I found that he compared the conditions which brought about the fall of the Roman Empire with the evolution of conditions that he had observed in America. Ferraro ascribes the cause of the downfall of the Roman Empire to "excessive urbanization"; in other words, the crowding of the people to the cities. He draws the parallel from the conditions he observed in this country and throws out a warning against the decline of America, the fall of advanced civilization from the same cause. If Ferraro is right in his theory, it seems to me that we can look to you men to see that it is only a theory, because I believe that, beyond any other single factor, the automobile and the automotive engineers are going to counteract that force to such a degree that history will not repeat itself in America. You are correcting "excessive urbanization." You make it possible for the man on the farm to enjoy the pleasures of the city to such an extent that he and his children will be more contented, get more out of life, and feel less inclined to gravitate to the city. You make it easy for him to come to the village or the city and to take his family to the "movies"; you make it possible for him to keep in touch with what is going on. You furnish him with a conveyance which enables him to go to his store, or for his doctor, or to visit his neighbor, almost as easily as he could do those things were he living in a city. You make it possible for that man, that great producer of things upon which we live and must live, to enjoy on the farms of these United States the same privileges and conveniences that he would enjoy if he moved to town. If the only danger that we have to look forward to in America is "excessive urbanization," then I look forward without worry, seeing as I do in you men and in your industry, the force which will always take the teeth from that danger.

Economic Reservoirs

Very few bankers have talked to groups of automobile men without in one way or another getting into trouble. One of the reasons is that bankers, for the last two or three years, have continually had to use the words "thrift" and "saving," which seem to be obnoxious to your trade. I believe that you do not hold any different view of thrift than I or the bankers of America hold. We do not mean penuriousness; we do not mean saving here and saving there for the individual gain entirely. When we talk about thrift, we mean setting up in this country economic and commercial reservoirs of wealth which permit the great development of industry and commerce. We want a reservoir of wealth built by saving, from which you can attract the capital that will enable you to plan and develop progressively while your established industries are at work on plans long since developed. We want a reservoir of wealth that, through investment, will permit the building of good roads, opening new territories for the tourist and the truck. Certainly your industry will profit by that.

I believe that there is no disagreement between the bankers and you on the proposition that we must have thrift in this country. You want your employees to save something and you encourage them by numerous methods and plans to do so. That is thrift. You want your companies to save some of their profits as they go along. That is thrift. While you desire more production that there may be enough of the things that everybody wants to go around, you must appreciate that something must be saved as you go along; and that is thrift. The great defect in the socialistic theory is that it apparently provides that current production should be used to consume current production, and that there should be no thrift and saving and accumulation of wealth. This is the great fallacy of the Socialistic doctrine. We have statutes at this very time which prohibit thrift from occurring as it should occur. We have an excess profit statute which means that your companies are making lavish and extravagant expenditures that they would not make if that law was not on the books; and such expenditures are made because the United States Government is paying a substantial part of the bill. When the profitable firm has reached a certain degree of profit every expense is considered in the light of the fact that the United States Government is paying a part of the bill of extravagance. You know as well as I that extravagance is supplanting thrift in the commercial enterprises of this country.

There is another law on our books that is taking away the incentive of thrift, the Income Tax Law. It is one law that is causing the men of large incomes in this country to lose the incentive to save. They strive for profit, but they delight in deductible losses. I have seen it in our business for months now. A man comes into the office and says, "I have a loss that I can deduct from my income tax return," and he smiles and is happy. If he comes in and says, "I have a paper profit," he looks as if he were going to weep when he says, "but I cannot include it, for the Government will take it away." We are all working to take losses, but not to take profits from which we can practise thrift; and if we are not able to save, we are unable to create that great reservoir of wealth which is necessary to commercial national development.

Unwise Tax Laws

There are three reservoirs of wealth in this country, from which we have to draw for all needs and developments, commercial, national and international. We have the reservoir of institutional wealth, the reservoir of large personal wealth and the reservoir of small personal wealth. In the past few years the first reservoir has been closed to investment demand because, under prevailing commercial activity and general inflation, institutional accumulation was scarcely adequate to meet the regular commercial credit demand. Institutional wealth has not been available for the buying of instruments of credit that run over a long period of time and support the development of this country, your roads, your own factory extensions and improvements. The next reservoir has been closed to investment demand by the income surtax. For more than two years the man of large means has not been buying bonds that are taxable. He could not do so. If he bought a taxable bond at par that carried a 6 per cent coupon, he had to give up in taxes from 50 to 70 per cent of that 6 per cent. It is perfectly obvious that with what was left to him of his income after the tax collector had been around, he would not buy something that would yield him an interest return of 1.8 per cent. He would rather buy tax-exempt securities, or go into a speculation, even though it were what we may call a wild speculation, because, if he lost, 50 to 70 per cent of the loss was the Government's loss, and if he won, the return even after payment of taxes would be substantial. The third reservoir, a broad one indeed but alas also very shallow, has alone been open for investment demand. That great

body of small investors has been increasing steadily by the tens of thousands in recent years, but their individual contributions are necessarily small and the adding machine runs up a total entirely inadequate to the country's needs. With this last reservoir alone open to us and with that of large personal wealth closed, we have not been and we shall not be able to support railroad extension and development, public utility extension and development, or the export trade. Let me add that if the most favorable railroad bill that could be conceived were to be put upon the statute books, if the most favorable public utility regulatory laws that could be devised were put on the books of every town and county in the United States, we still could not finance those utilities and those railroads so that they could extend and improve and give the best service to this country. This is because the bulk of the financing must be done through fixed maturity obligations for which there is and must be, until our tax laws are revised, a demand totally inadequate to the supply. There are not two railroads in this country, I think I am speaking conservatively, that could finance through stock today, and as for public utilities, none has had the temerity to attempt stock financing in many a long month. In the case of foreign government finance, bonds are the only feasible form of debt to be offered, and we are not able to sell foreign government bonds in sufficient volume to support an export trade because the institutional reservoir and that greater reservoir of large individual wealth are closed. We have only to look to that great body of small investors whose total bond purchases fail to make even a dent in this great foreign situation.

Export trade is the only basic form of demand that we have had in the past year. Railroad commodity demand for improvements has been looked upon year in and year out as barometric of the times. That demand we have not had in 1919. The demand of utility companies for extensions and improvements has likewise been absent. Export demand is the only basic one that we can point to that has been in evidence in the past year or is in evidence today. It will pay us to realize fully the importance of the foreign demand for our commodities and to gage the likelihood of its continuance. I do not wish and do not feel that I am able to discuss the question whether and to what extent foreign countries need our goods. There is a great difference of opinion on that. If you read Sir George Paish, you will think that far-spread famine and international bankruptcy are threatening unless Europe gets our goods by the billions. If you read Mr. Hoover's recent statement, you will see he thinks we do not have to do very much to keep Europe from hunger during the coming year. Authorities differ. Frankly, I do not know whether Europe and the countries that have been devastated by war absolutely need our goods or not. The one thing that I am sure of is that we must have the export trade; that trade we cannot get along without.

Export Trade Essential

I have heard the statement made often enough that we are a self-contained country and can get along without any export trade. There never was a more ridiculous statement. Let us take one illustration. In the South they grow 12,000,000 bales of cotton a year. We have facilities in this country for turning into fabrics between 5,000,000 and 6,000,000 bales of that crop. The remainder must move in foreign trade. Now, unless we can find the way to export the rest of that crop and finance that movement, you will see cotton back up in the South, lying in the hands of factors or unsold in the hands of producers, with non-liquidatable cotton paper crowding the banks. Under such circumstances the Southern farmer will, from necessity and not from choice, reduce his producing acreage and curtail his use of labor. He will retrench; his labor will retrench. The commodity buying of the South will be at a low ebb indeed. How long will the now prosperous South continue to buy your automobiles when that occurs? No, we are not a self-contained country today. Given time, say five years, we might, by readjusting the character of production, become self-contained, but as matters stand this year we must have an export trade. You may disagree and contend that the activity of domestic commerce, the degree of domestic buying in all lines of commodities, will keep our factories going and bring a continuance of prosperity; but I answer that the domestic buying movement of today is unbasic, unnatural and ephemeral in character. The money that is being spent so lavishly today is very largely money that has been made easily, during the war and since, and it is being spent just as easily. It is money that was saved and invested in Liberty Bonds during the period when we enforced thrift in this country, and such investments are being cashed in, as the mental burden of the war is lifted. We are having distribution of wealth today, to be sure, as the result of our tax system, but is that small wealth in the majority of cases being saved in any substantial part? No, it is being spent, and we are having a buying demand as a result thereof such as this country has never seen. What will stop it? I see no immediate stoppage, except as this export demand ceases. Then it would stop rapidly, for our raw products would back up on the farm and in the producing communities to such an extent that from one end of the country to the other you would find a curtailment of buying power that would extend to the city and throughout the land. I say that we must have export trade! But export trade can be had only as it can be financed. How have we done it in the past, and how can we continue to do it?

The balance of trade in our favor in this past year was approximately $4,000,000,000. We established dollar credits for that to the extent of about $1,750,000,000 out of the balance of the $10,000,000,000 fund created by the United States Government for foreign lending. We were able to distribute foreign government securities to the American public to a total of approximately $250,000,000 above the necessary refunding operations and there was left $2,000,000,000, the financing of which we can account for only in one major way. The merchants, the manufacturers and the exporters of this country supplied credits privately, to foreign buyers. Now while those credits were not made directly by banks and did not perhaps find lodgment collaterally in banks, they always affected the banking position because they drew from the quick-asset position of each man or corporation who extended the credits. Either bank deposits were reduced or bank loans were increased in the aggregate of this approximately $2,000,000,000 balance.

Credit Expansion

During the war, and in the past year, we have been leaning heavily upon the Federal Reserve Banking System, a system that has permitted great expansion during and since the war period. Higher prices for everything, high wages, greater stocks of material in transit, larger inventory accounts and increasing receivable ac-

counts, have all shown in that bank statement, week by week, the expansion of the loan and currency accounts and decreasing reserve ratios. But there is a roof even to the credit expansion of the Federal Reserve Bank. There is a point to which the Federal Reserve Bank is not able to go in the expansion of credit in this country. We are gradually, and I am sorry to say not very gradually at that, approaching that point. You have heard the Governor of the Federal Reserve Bank in Washington sound many a note of warning in recent months; and that warning must become a commanding note. One thing is certain, your banking system cannot support this year a repetition of the expansion that occurred in 1919 through the export trade balance of $2,000,000,000. It would seem likely that export trade would fall off sharply in 1920. If it does, I ask you to judge whether the present degree of national prosperity can continue? What can be done to save the situation? We can practice individual and corporate thrift, and by paying off our borrowings see to it that the banks are relieved. We can thus make a hole in the credit expansion of the Federal Reserve Bank into which we can tuck additional credits for foreign trade. There are, perhaps, two possible other ways, though frankly I am hopeful of neither. One is to sell the securities of foreign governments or industries to the American public. We have been discouraged about that of late, because we find that the American public generally is not over eager for foreign securities, and we must under existing tax laws eliminate large individual wealth as a buying factor. The total of such securities that we are able to distribute at present makes no more than a dent in the situation. The other possible way is through further lending by the United States Government. But the United States Government, through the office of the Secretary of the Treasury, has announced that it does not propose to make any more loans. I do not know how the Government could make any loans, except as it raised the money by issuing a non-discountable bond of some sort, which I doubt if the country would leap to take in any great volume. I do not believe that the United States Government will and I am not saying it should do it. The way to finance foreign trade is through private capital, but taxation is the block. I believe that our legislators will not reverse their position on personal taxation, for the mass of unthinking voters would scarcely be sympathetic. But it is essential to American commerce that our tax laws be revised.

Things in Washington today are not measured by commercial advantage. In this presidential election year they are measured by the yardstick of political expediency, and except as you and I, through our efforts exerted to the utmost, can change popular opinion and let the legislator who has his ear to the ground know that popular opinion calls for measures that will save the situation, I feel that nothing will be done. And so I see troubled waters ahead. I see a time for commercial caution. Mind you, I am not a pessimist; I believe in the American people right down to the ground. I believe in America. I believe that in the end, America, with her great natural resources, wealthier by far than any other country on the face of the globe, with such men as you in the vanguard of progress, and with her great fundamentally sane working classes, aside from those who have claimed to be in that class and who are now "the goods" in the export movement that is taking place from Ellis Island, will "carry on" to a premier position among the nations of the world.

I am not afraid of the future. The future of the next year or two is not altogether clear, but as to beyond that period, I am a great optimist. We may have some depression, something that will bring about a deflation in our prices, a deflation in currency, possibly a deflation in labor, all of which are desirable and probably absolutely necessary things that will put us where we must be, in the leadership of the nations of the world.

ADDRESS OF MAJOR ARTHUR BLES

I WILL tell you tonight something about the psychological aspect of the great war, and of what we must do to make the sacrifice to which America, in common with all other rightly thinking nations, consented, a useful sacrifice and not a futile waste of life, money and time. I have been told since I came to this country that the American people would not listen to stories of the war now that it is all over. First, it is not all over; any clear-minded person can see that at once; and secondly, I am certain that the desire to forget the war is only a fleeting expression of a passing state of mind, for no country that reveres its great men as this country does, and in the hearts of whose people are enshrined such great courageous citizens as George Washington, Abraham Lincoln and Theodore Roosevelt, can, in its heart of hearts, wish to forget those splendid American soldiers, who, as soon as they were able to do so legally and, as I know from experience, a great many of them did not wait for that moment to join hands with us, went across and helped us to win the greatest victory in the history of the world.

It is an axiom of statesmanship that we must prepare for war if we wish to retain peace, and we know that if England and America had been ready for war and had had armies on Continental lines in 1914, the world would have been spared the appalling disaster which overtook it and upset things to such an extent that even now, fifteen months after it is all over, we are no nearer the normal condition of affairs than we were on armistice day. On all sides we have strikes, not as in pre-war days, simply for higher wages enabling men to live under better conditions, but strikes of a clearly revolutionary character, such as the great railroad strike in England organized by German money to upset the life of the country and play into our late enemy's hands, and such as your own longshoremen and miners declared recently, in which the hand of Germany through the I. W. W. is again as clear as the writing on the wall.

Did not Germany imagine in 1914 that the British Radicals and the French Socialists would prevent England and France from putting forth their full effort? And now that we have won, do you think that Germany is attempting to forget the war? I know by experience that she is not, and in spite of her camouflage revolution and the foundation of her so-called Imperial Republic, I know that the men who started the great war are still at her council tables.

War Not Over

Germany is very angry, for she has not only been beaten as no other nation in the world ever was beaten, but she has been humiliated by every clause of the armistice and the Treaty of Peace, and she is not only biding her time for taking her revenge, but she is preparing actively. She will not do it above board and we need look for no outward and visible signs of her preparations, but she is none the less dangerous, and if she can ever make us pay for the humiliation she is undergoing

at present, she will not fail to do so and charge us 1000 per cent interest on her outlay.

And yet I am asked to believe that the greatest republic in the world wishes to forget the war now that it is all over. You, yourselves, have not even as yet signed the material instrument of peace. Even if you had, the war will not be over until Germany has given irrefutable proof of her sincere repentance and determination to play straight in the future. Up to the present all indications point in the opposite direction.

To celebrate the return of your armies from France you raised a beautiful triumphal arch at the junction of Broadway and Fifth Avenue, bearing on its pediment the inscription, "In memory of those who made the supreme sacrifice for the triumph of the free peoples of the world and for the promise of an enduring peace," and lower down, names which will make the American soldier glorious for all time; Seicheprey, Cantigny, Belleau Wood, Chateau Thierry, the Marne, St. Mihiel. Now is it fair to the men who at the cost of their lives or their bodily strength placed those names on the flag of your country that you should even try to forget the war? What is the use of raising monuments to them in our cities if we are going to forget them in our hearts? We cannot get away from the essential fact that to forget the war means forgetting those who won it for us.

I am convinced that if the story of the war be told in the right way, divested of all its horrors and misery, but on the contrary clothed in all its splendor of intelligent heroism, no people in the world would be more anxious to hear about the war than the keen, eager-for-knowledge people of this country. By the right way, I mean showing how the war was won by superior brains, what incredible mistakes Germany made in both diplomacy and strategy, and how in every instance advantage was taken of those mistakes, by the Allied leaders, for the cause of right against apparently invincible might. It is of the utmost importance that we should bear this constantly in mind, for it means that if we wish we can maintain our commercial supremacy in the coming fight for the world's markets with the same facility as that with which we maintained our military supremacy on those glorious fields of France and Flanders. And it must not be lost sight of that Germany will wage this new war with just as much bitterness as, and with far greater skill than, she displayed in her fight for military laurels.

PRESIDENTIAL ADDRESS OF CHARLES M. MANLY

(*Concluded from page* 146)

most important thing we have before us today, cooperation. One of the greatest impressions left upon the minds of the general public by the war is the power of cooperation, and one of the most important factors in achieving cooperation is organization. Three of the necessary elements that must be agreed upon in advance to enable successful organization to be achieved are aim, scope and plan. I am thoroughly satisfied that we, as engineers, will fall far short of our opportunities in the immediately approaching years, if we do not get into proper step with the tendency of the times and take an active part in securing the general cooperation of the technological engineers of this country. Our aim should be as broad as the definition I have previously quoted of "Engineering," to render the greatest service possible to mankind in general, and our Nation in particular, through the direction of human effort along technological lines and the conservation of our natural resources, and to secure suitable public recognition of the proper status of the engineer. The scope of the organization should change from time to time as the possibilities and exigencies of the situation require. The plan must fit the scope, and must be carefully guarded to prevent over-organization. Both the scope and the plan will naturally be subjects of wide differences of opinion, but if we are equal to our opportunities, we shall certainly be able to agree on suitable compromises, for the very groundwork of cooperation is compromise. The breadth of our mental training and capacity will be largely measured by our willingness to keep away from pettiness.

While we must be most careful to exclude any taint of politics from our objects and our point of view, still we must of necessity take a deep interest in legislation that affects the public welfare along lines in which our technological training makes us especially competent to judge the wisdom thereof, and it is our duty to speak as a body in most definite terms on such matters, and to insist upon being heard. If we are as potent as I believe we are, and have described us as being, in helping to shape the welfare of mankind, we should not, in these important matters upon which we are most competent to speak, hold our tongue for fear of transgressing some unwritten law or code that is based upon the theory that the man who never does anything never makes mistakes.

In this matter of shaking off conventions that have hobbled our freedom of expression concerning subjects on which our special training and experience qualify us to speak and act, and of securing proper recognition for what we do accomplish, we shall miss the greatest opportunities for proper recognition that have ever presented themselves if we do not, in connection with the drastic changes which are taking place in industry, seize all available opportunities of demonstrating that not only is technological training and experience no handicap to a business executive, but that it is the best foundation possible for the successful administration of the business of industry. If we cannot keep free from pettiness, this last suggestion is based upon a false premise.

Military Traffic Control in Relation to Highway Traffic

By Col. Mark L. Ireland,[1] U. S. A. (*Non-Member*)

MOTOR-TRANSPORT men with military experience talk mysteriously about "traffic control." It is a subject uppermost in their minds. It is clear that they are not talking about that type of traffic control which one sees upon the city streets. Military traffic control is much more inclusive than the city type, but it seems difficult to define its boundaries, to determine its form and outline. It therefore seems proper to inquire just what is meant by the term and what part traffic control is to play in the future of highway transport.

Definition of Traffic Control

Traffic control is a function exercised by the higher commanders to secure the best possible approach to the practicable passenger or ton-mile-hour capacity of roads and terminals. It cannot be exercised by lower commanders, because they are unable to make suitable provisions for (*a*) bringing new independent formations into the battle area, (*b*) coordinating highway and railroad traffic, (*c*) making uniform traffic-control regulations, (*d*) avoiding diversity of authority over single routes, (*e*) deciding priorities of traffic on congested routes, and (*f*) facilitating the application of Inter-Allied traffic-control regulations.

Traffic control is not concerned with measures relating to the efficient use of vehicles, their suitability for their cargoes, proper loading, fitness for service, appearance and like questions, nor for their road discipline, as individual vehicles or as organizations, when this road discipline affects only maintenance of vehicles. These are questions of motor-transport control, or command. Traffic control is vitally concerned as soon as any of the above points affect the time that a vehicle takes in passing over a given stretch of road which happens to be under traffic control, the degree of congestion on this road and the wear-and-tear upon the road surface. It involves not only the giving of orders for the dispatching of transportation, but more particularly observation of how the dispatcher's orders are carried out as to routes, time schedules, cargo loading, condition of vehicles en route, road discipline, etc. In fact, dispatching of transportation follows immediately upon the purchase of the vehicles, in either civil or military experience. Maintenance is the first lesson for the adventurer in the field of motor transport. The necessity for traffic control is the second lesson. The third is that the traffic-control system, like its counterpart in railroad operation, must supplement and be a part of the dispatching system.

Traffic control is therefore a development from an expensive and chastening experience in amateurish handling of motor transport. In the commercial as well as the military world, we have been accustomed to handling only small quantities of passenger or freight cargo on the highways. The skill and experience of our forefathers in operating the stage coach and the post road never developed a heavy traffic as reckoned in present-day quantities, and their practice has to a large extent died with them. The quantities which we have been accustomed to carry by highway never involved economic problems much beyond the single-wagon load. The motor transport age, although still in its infancy, has changed all this.

The war has brought us to a stage of development and knowledge of the possibilities of motor transport and the highway which we could not have reached for many years in peaceful experience, for the reason that peace-time demands could not create a need for such large volumes of motor transport. Hence, for several years to come, the motor-transport officer must be the pioneer in the development of the science of economic quantity-transportation on the highway.

In previous wars the affairs of "the train" were almost beneath the dignity of more than passing attention from the higher commanders. The encumbrance and difficulties arising from problems of the military train were almost like bad weather. They usually occurred at the same time. Hence, it was not difficult to divert attention from bungling, inefficiency and ignorance of the importance of the train to the conveniently contemporaneous bad weather. A few great captains appreciated the bearing of the train and its affairs upon their success in a campaign. Napoleon did the military train both a great service and a great injury when he coined the maxim that "an army marches on its stomach." Putting his own interpretation upon his maxim, one which many commanders since his time have wholly missed, he improved his trains and thereby acquired a mobility which enabled him for years to defeat the larger forces of his enemy by a superior ability to get heavier concentrations at the proper point at the critical moment. The loss of horses in his trains, quite as much as in his cavalry, told the story when the tide turned against him. He was no longer able to concentrate his inferior forces against one army at a time and beat his enemy in detail.

Other captains have dodged the problem by cutting loose from their bases and living upon the country as raiders. Sherman's march from Atlanta to the sea was in reality nothing more than a large-scale raid from a base which could not be pushed forward to a new one.

Military Train Development

The hopelessness of marked improvement under the limitations of animal transport prevented any marked advance in military train operations for thousands of years. Will motor transport be able in a few years to break the fettering bonds of military habit? Napoleon's injury to the military train lies in burying its fortunes under but a portion of its burden, the load of supply. This escaped attention until after the advent of motor transport, because the passenger load was carried upon the animal itself without a vehicle, and was called cavalry or mounted infantry. The great value of the flexibility of purpose of motor transport must be grasped.

[1] Motor Transport Corps, Washington.

The military train had nothing to do with military passenger traffic worthy of any serious attention. The mounted service has always made in every nation a strong appeal to the popular taste. The people have loved the spectacular side of the war, the rush of troops into battle in the nick of time. The work of the cavalry in the war should not be belittled. It was almost everything that had not been expected of it. It was disappointing to the true cavalryman in almost every way. Not only did he not ride into battle on his charger, except in very rare instances, but he saw even the artillery horse ride into battle in a motor truck. And mounted infantry is an obsolete term except to describe the infantryman who is hurried over 5 to 8 days' marches in a motor truck in 1 day or less. Not only does the hope of "the train" of the future lie in the fact that it has become the carrier of military passengers, but this fact carries with it the army's hope of victory. Army reserve trains and a traffic control which can arrest for the moment ordinary routine supply traffic to give priority to emergency troop and supply movement, form the keystone of the bridge of military traffic. An army which aspires to an honorable record of fitness for its task, of ability to meet the burdens and problems of modern warfare, and desires a chance for victory when it accepts battle, willingly or unwillingly, must acquire and retain superior mobility. This can come only from a thorough understanding of the necessity for keeping the motor transport of an army "in hand", in large reservoirs, under the will of higher commanders.

The power of mobility given by motor transport must not be frittered away by a piecemeal distribution of perquisites of position for anyone and everyone. The supreme commander must not find himself blocked and thwarted in his efforts to stem an enemy offensive or to seize a favorable opportunity for a counter-offensive. Available reserves of men, guns, supplies and motor transport must not be useless luxuries in a crisis because the man who is fighting the battle cannot control either the roads or the motor transport. Roads need not be blocked by the routine traffic of subordinate commanders. It can accomplish quite as much in the same time by using its allotment of road capacity.

Traffic Control in Civil Life

Traffic control started in civil life. The part which fully-developed traffic control is to play in civilian life is beyond the power of any person to predict because we are still too far away from concentrations of traffic which tax the 100 per cent capacity of highways. It is still too easy to divert traffic to new routes, to widen or otherwise improve congested streets. Even military traffic control is still in its infancy. The highway problem is not yet sufficiently acute in civil life to demand an approach to the solution forced upon military men. When the time comes the civil problem will be more difficult because the traffic will lack the unity of purpose and the discipline of military traffic. The civilian traffic current teems with individuality and restiveness under restraint or guidance.

The solution will be in different form and slower, because the need for it will come more slowly and rampant individuality must be coped with. However, it must come. The most important centers of traffic already have tower-control stations similar to the interlocking switch and signal towers of a great railroad terminal. Lest the solution be disastrously late it is none too early to give the matter the serious thought it deserves.

MARCH COUNCIL MEETING

THE meeting of the Council held on March 11 was attended by President J. G. Vincent, Past-president C. M. Manly, Vice-presidents W. G. Hall and Glenn L. Martin, Councillors F. M. Germane and N. B. Pope, Treasurer C. B. Whittelsey, Chairman B. B. Bachman of the Standards Committee, Chairman H. M. Swetland of the Finance Committee, Chairman David Beecroft of the Meetings Committee and Dr. H. C. Dickinson, of the Bureau of Standards.

Fifty-four applications for individual membership and five for student enrollment were approved. D. T. Gleason and Harold Nutt were transferred from Junior to Member grade, and William H. McConighen from Associate to Member grade.

It was reported that ninety-two applications for membership were received during the month of February, as compared with eighty-two for the same period in 1919; also that on March 1 there were 4618 individuals and companies on the rolls of the Society, including affiliate member representatives and enrolled students.

The following appointments to the Standards Committee were made, with assignment to Division as indicated:

Major H. C. Muhlenberg—Aeronautic Division
L. A. De More—Electric Transportation Division, Industrial Truck and Tractor Subdivision
R. W. Randall—Isolated Electric Lighting Plant Division
Geo. L. Elliott—Non-Ferrous Metals Division
C. W. Pack—Non-Ferrous Metals Division
Lon R. Smith—Stationary Engine Division

The following additional subjects were assigned to Standards Committee Divisions:

Die-Casting Alloys—Non-Ferrous Metals Division
Control-Lever Ball-Handle Inserts—Transmission Division

President Manly was appointed as the representative of the Society on the Highway Economics Committee of the Engineering Division of the National Research Council.

COMMERCIAL AND MILITARY POSSIBILITIES OF AIRCRAFT

THE airplane of today is a practical machine which can be made with a cruising radius of from 20 to 30 hr. by the use of a series of engines of which two or more are for auxiliary purposes only; while the airship can, as has been proved by the performance of the R-34, stay in the air 80 hr. and more.

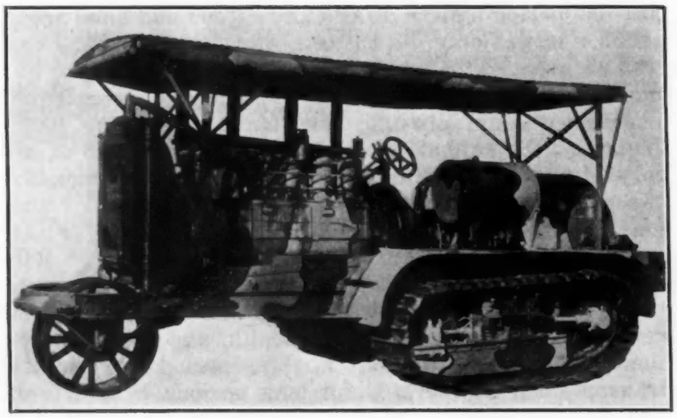
The future development of the science of aeronautics depends largely upon whether the public wants it to grow or remain stunted, particularly insofar as the commercial status of aeronautics is concerned. However, the military end must continue to keep abreast of the times, as fighting craft have proved their worth in the world war. Everyone knows that the army which does not have a competent air fighting force cannot hope to compete with its enemy. Therefore, it is obvious that the armies of the world will devote their efforts to the development of aircraft for their own protection.

Artillery Motorization as Related to Caterpillar Traction

By GEORGE W. DUNHAM[1] (*Member*)

CHICAGO TRUCK AND TRACTOR MEETING PAPER *Illustrated with* PHOTOGRAPHS AND DRAWINGS

THE Ordnance Department, through the chief of its technical staff, Col. C. L' H. Ruggles, has requested me to lay before you the problem of artillery motorization, and to solicit your interest, assistance and moral support in working toward its solution. Motorization as accomplished in the recent war could hardly have been effected without the assistance of this Society, which represents almost 100 per cent of the automotive engineering talent of America. Recognizing the necessity of continuing this motorization movement and the fact that much of this development has been accomplished by the creative ability of the members of the Society, it is the object of this paper to attempt to interest further those who have already aided this development and to arouse the interest of those who have not yet come in contact with the special problems of artillery motorization and cross-country mechanical transport in general.



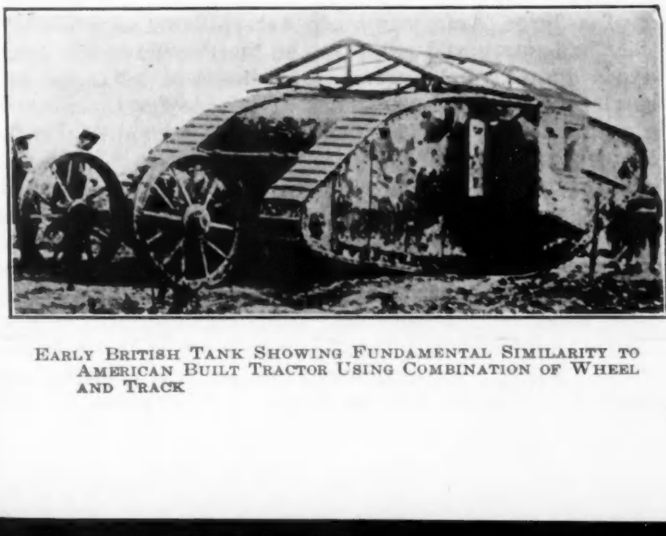
120-HP. AMERICAN-MADE CATERPILLAR USED BY BOTH ALLIED AND CENTRAL POWERS TO HAUL GUNS OF LARGE SIZE

Without question, the greatest single advance in military engineering since the fourteenth century is that of motorization as developed during the recent war. From the first authentic record of the existence of the cannon, reference to which appears in the journal of the city of Ghent, in 1313[2], up to the highly refined field gun and cannon of 1914, the two fundamental ideas kept in mind by military engineers in designing cannon have been to secure the maximum range and hitting power consistent with the mobility limitations of horse transport. It was only in 1914 that the United States considered the art sufficiently developed to warrant the hope of successful artillery motorization. In 1916 a fully motorized medium heavy battery was organized in this country and the first fully motorized artillery regiment in the world, the Ninth Field Artillery, in Honolulu. (See Fig. 1.) This removed the incubus of lack of mobility that had limited the ordnance engineer in design and handicapped artillerymen in battle from the days of catapults.

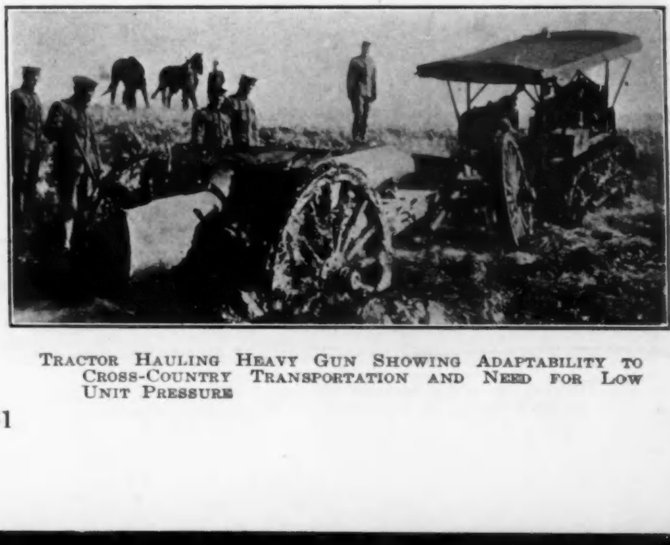
Since that time, and particularly during our participation in the great war, military requirements, as interpreted by leading ordnance and artillery engineers, have so changed the conception of mobility, that to date, with the exception of about 66 per cent of the 75-mm. guns in the combat division, the motorization of all mobile weapons of the United States artillery is an accomplished fact, and a recommendation for the ultimate motorization of those not now motorized has been approved.

In taking this big step forward in such a short time, and particularly because of the exigencies of war, it was impossible to make the design of the vehicles involved as complete or as consistent as could be desired, it being necessary to use the equipment most quickly available and to adapt it wherever possible to that used elsewhere in our Army. Thus, there are certain discrepancies in design to which your attention will be directed later. It is the function of this paper to get the members of this Society, who have helped to accomplish this remarkable forward step in military engineering, to help iron out these discrepancies, maintain interest in the problem of motorization and thus make our country, through its mechanical skill and inventive ingenuity, possessed of

[1] Consulting engineer, Militor Corporation, Jersey City, N. J.
[2] "Item; in this year was the first discovery of the use of cannon by a monk in Germany."



EARLY BRITISH TANK SHOWING FUNDAMENTAL SIMILARITY TO AMERICAN BUILT TRACTOR USING COMBINATION OF WHEEL AND TRACK



TRACTOR HAULING HEAVY GUN SHOWING ADAPTABILITY TO CROSS-COUNTRY TRANSPORTATION AND NEED FOR LOW UNIT PRESSURE

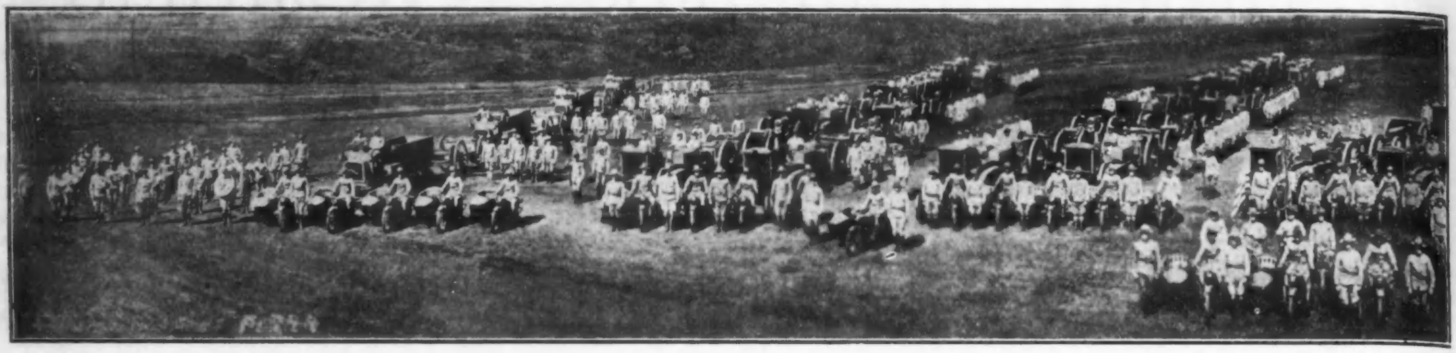


FIG. 1—NINTH FIELD ARTILLERY, THE FIRST FULLY

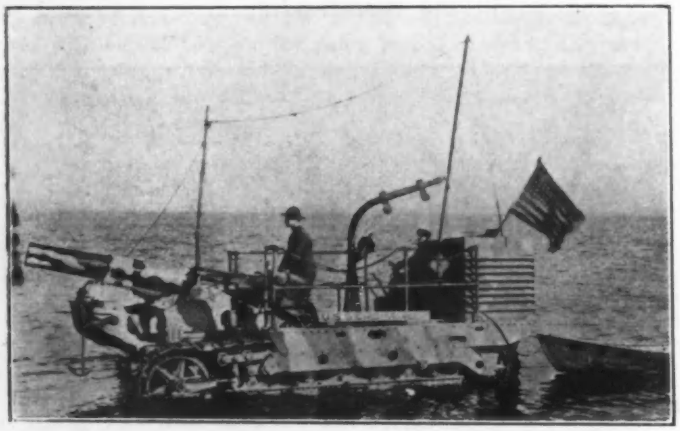
the best and most scientifically-equipped army in the world.

In connection with the solution of a problem of this kind where the skill of the civilian engineer is bent toward solving a military engineering problem, there are two important relationships to keep in mind: (a) the influence of the present state of the art of automotive engineering upon the military problem, and (b) the influence of the development of the military problem upon the art itself. This latter conception in the case of artillery motorization is highly important.

The war has demonstrated to us the wonderful possibilities of the caterpillar tractor. This construction met with sufficient commercial resistance in the past to retard its development somewhat. There have been a limited number of manufacturers who were interested in perfecting this type. One of the big factors in winning the war was the basic principle or the idea which resulted in the design and creation of the "tank," namely, the caterpillar or track-laying form of construction. This type had, before the war, made possible agricultural accomplishments under conditions that could not otherwise have been met. It is now recognized as an essential means of transportation in logging camps, oil fields, mines, cane and rice fields, etc. As the art of caterpillar traction advances for military purposes, so will these other uses be elaborated and peace-time industrial engineering will thereby be made to advance.

History and Advantages

Before approaching the technical factors involved in the problem of artillery motorization, it will be best to provide a perspective by roughly sketching the history of artillery motorization. As stated before, range and hitting power have been from time immemorial the two obviously desirable cannon characteristics. As one army has made progress in these two factors, others have taken steps to offset them, so that the various big-gun equipments of all armies among the major powers is at any one period a more or less understood and fixed proposition. It was only during this war, in which the strain was so great as to necessitate reinforcing men and animals by every means which engineering, science and machinery could provide, that substitutes were finally found for the animals which have, since the dawn of history, limited the mobility of armies. Only a moment's thought need be given to the fixed limitations of such animals; to their proneness to disease and vulnerability to climatic changes, gas and bombs, as compared with mechanical transportation; to the necessity of feeding them whether they are working or not; to the extreme care necessary to protect their health, and to the limitations in the length of their working period. Mechanical transport can be operated for long periods without rest, and any "sickness" can be cured within a few hours. The motorization of one 155-mm. howitzer regiment saves 1440 horses and 400 men. One tractor for this howitzer is the equivalent of 10 horses, and yet it is so compact that when packed it occupies but 360 cu. ft. The horses in a regiment equipped with this caliber of gun consume daily 36,000 lb. of forage, whether the animals are at work or idle. The same regiment with its equipment motorized consumes but 29,000 lb. of fuel, oils and greases, when moving 50 miles, which represents a 2-days' march for such a command in a period of vigorous activity and 10 days of average war movement. Furthermore, it stops this consumption when idle and there is a corresponding saving in personnel. Tractors are far more easy to "camouflage" than horses. A shrapnel burst which will kill every horse with a gun will usually leave one of these armored tractors uninjured.



SELF-PROPELLED GUN MOUNT SHOWING ABILITY OF PRESENT CONSTRUCTION TO OPERATE ON SUBMERGED GROUND

When France and Germany went to war, the Germans used a large American-made caterpillar tractor which they had purchased prior to the war to move the great Skoda guns from Austria into Belgium. France and England used this same make of vehicle for their heavy equipment, but at that time and even when the United States first went into the war, the policy of France, England and a considerable percentage of American military opinion were against general artillery motorization. The belief in the possibilities of motorization on the part of certain leading spirits in the ordnance and artillery services, combined with the growing pressure of military requirements, changed this opinion completely. These factors, combined with the able assistance of the members of this Society, gave motorization its real impetus and made America the leading factor in this phase of war

MOTORIZED ARTILLERY REGIMENT IN THE WORLD

engineering. The carriage division of the Ordnance Department in particular deserves great credit for the manner in which it expanded to meet the fast-changing conditions and the manner in which the whole problem was handled.

In the extracts from the Westervelt report which are given in the Appendix, it will be noted that under the guidance of the Ordnance Department, through its tank, tractor and trailer division, the following general mechanical development with respect to artillery motor equipment had been accomplished at the date this report was submitted:

(1) An efficient 10-ton artillery tractor for pulling heavy gun loads has been designed, tested and contracts for 2800 have been placed, of which 933 are in France
(2) An efficient 5-ton artillery tractor for pulling medium gun loads has been designed, tested and 4000 are in production, of which 1018 are in France
(3) Efficient heavy mobile repair shops have been designed, tested and 17 shops of 2 sections each put into production, one of which is in operation in the occupied zone of Germany
(4) An efficient artillery repair truck has been designed, tested and 420 of 1332 being produced are in France
(5) An efficient 3-ton four-wheel-drive truck has been designed, tested and adopted as standard for use in the Army
(6) Caterpillar tracks to replace wheels on certain heavy guns
(7) The following have been designed, built and are being tested:
   (a) 2½-ton tractor
   (b) Heavy motorcycle for artillery
   (c) Self-propelled gun mounts for various weapons
   (d) Cargo-carrying caterpillars or tractor caissons
   (e) Cargo caterpillar trailers

It can be stated with respect to (1), (2) and (3) that the United States is far in advance of all other world powers.

While some of these vehicles may be open to criticism as to various details, all of those put into production are good practical mechanisms that function satisfactorily. As previously mentioned, the necessity for haste prevented a complete and consistent design, which explains the discrepancy indicated in Table I with regard to excessive power in some vehicles and the lack of consistency in the type of unit used and its design. The commercial product of an American tractor manufacturer was used as the basis of these designs, and upon this were installed various available power units which, although not designed for this particular type of service, nevertheless functioned satisfactorily.

CATERPILLAR VEHICLE CHARACTERISTICS

In order that you may see the work that has been accomplished in this manner, various illustrations have been included with this paper showing the more important pieces of equipment that the tractors have to handle, as well as the tractors themselves. A number of views of tanks, self-propelled gun mounts and related apparatus are also included to show the various military ramifications of cross-country transport.

While this paper deals primarily with the use of caterpillar traction in artillery motorization, it must be appreciated that many wheel types of vehicles, such as the mobile repair shop, various trailers, etc., some of which are shown, are a necessary part of the artillery motorization requirements and are today in a stage of development equal to that of the caterpillar traction development.

Before taking up some of the more important principles of caterpillar application to military requirements, I wish to make it clear that this paper does not attempt to indicate the final solution, but states the problem as it is known today. It is to be hoped, however, that a statement of the problem and of the requirements and present conditions will result in many valuable papers and much discussion.

A more or less conventional caterpillar tractor construction is here described for the benefit of those who are not familiar with this type of vehicle. Fig. 6 is a diagrammatic sketch of one of the caterpillar tracks and supporting mechanism of a military tractor. The engine and operating mechanism is carried in a chassis frame which is supported on a number of small wheels or truck rollers that in turn run on an endless belt or flexible track which acts as a medium for distributing

A 10-TON TRACTOR PULLING A 4.7-IN. GUN AND CAISSONS WEIGHING 17,000 LB. IN THE NOVEMBER, 1917, TEST AT ROCK ISLAND NEGOTIATING ROCK PILE

TABLE I.

Vehicle	Gross Weight, lb.	Pressure per sq. in. Hard Ground No Penetration	Pressure per sq. in. Soft Ground 5-in. Penetration	Drawbar Pull, lb.	Drawbar Pull in Percentage of Total Weight	Maximum Speed, m.p.h.	Engine Make	Engine Number of Cylinders and Dimensions, in.	Engine Piston Displacement, cu. in.	Engine Governed Speed, r.p.m.
2½-ton Tractor	7,700	40.8	5.53	4,280	55.6	12.00	Cadillac	8–3⅛x5⅛	314	2,000
5-ton Tractor	10,500	24.5	4.90	8,100	77.1	7.87	Modified U. S. A. Class "B"	4–4¾x6	426	1,280
10-ton Tractor	21,500	29.1	6.70	13,650	63.5	4.19	Holt	4–6½x7	929	600
3-ton Tank	6,700	8.4	6.22	3,760	56.1	7.76	Ford[3]	4–3¾x4	352	1,700
6-ton Tank	14,500	6.8	4.70	11,300	77.9	5.45	Buda	4–4¼x5½	312	1,300
Mark VIII Tank	80,000	13.5	5.45	75,700	94.6	5.20	Modified Liberty	12–5 x7	1,649	1,400
Mark VII Tractor Caisson	20,000	23.0	5.53	16,180	81.0	7.87	Modified U. S. A. Class "B"	4–4¾x6	426	1,280

[3]Two engines used. Displacement is total of both.

the weight of the vehicle over the area of contact of the track with the ground. The track itself is supported on two larger rolls or sprockets, one of which is power actuated, thus making a vehicle construction having in effect elongated wheels, with a large wheel or track area in contact with the ground and resultant low unit pressure.

The unit pressure of the track in contact with the ground is much lower than could be obtained with the more simple wheel construction and is the prime reason why this type of vehicle is capable of better performance under extremely adverse ground conditions. Roughly speaking, the static unit pressure of an average-size man is about 6 to 8 lb. per sq. in., this pressure increasing by 100 per cent when he lifts one foot to walk. That of a good-sized horse will be found to be about 16 to 18 lb. per sq. in. staticly and more than twice that in action.

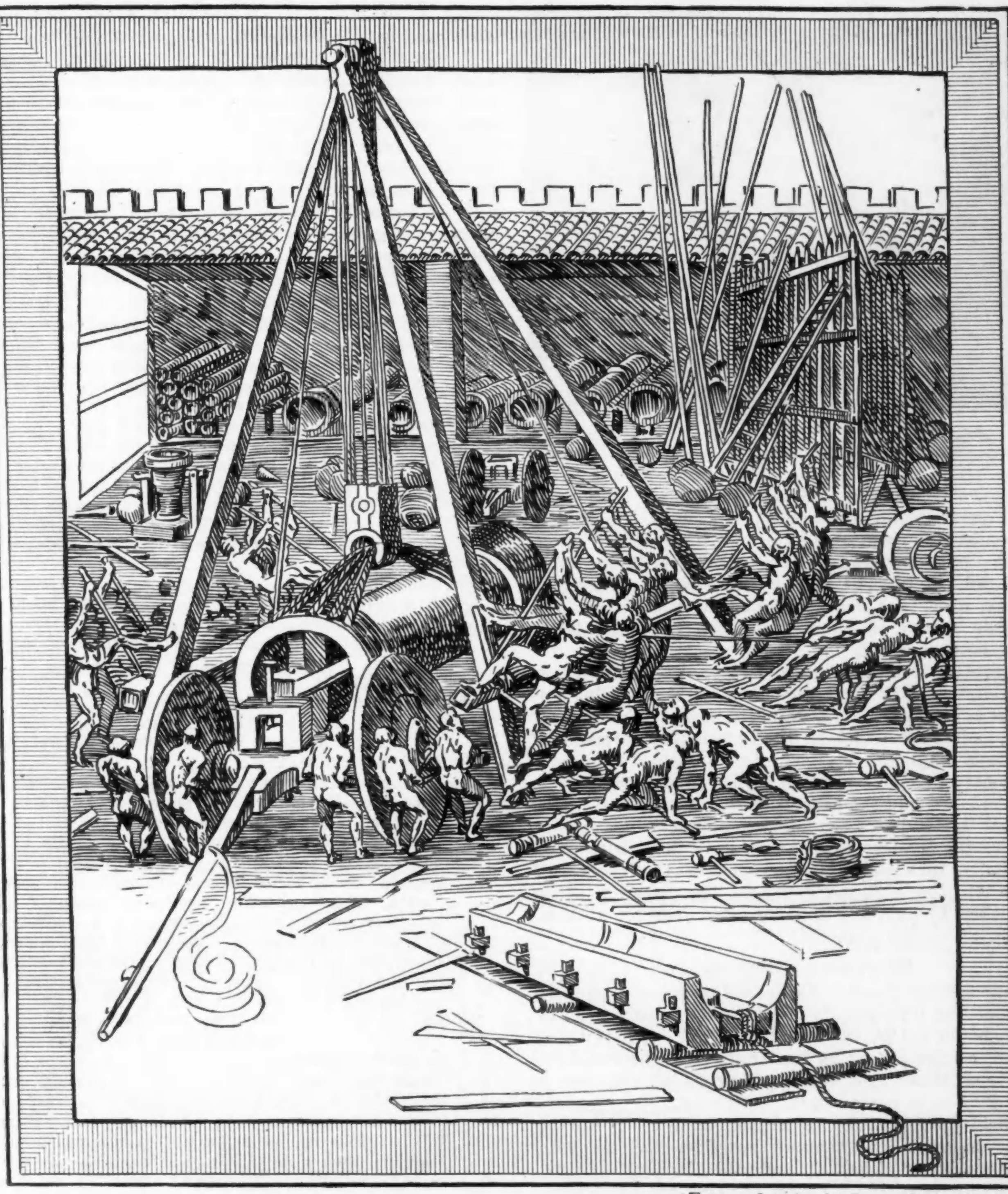
Referring to Table I, the highest unit pressure shown, in the data tabulated, is less than 7 lb. per sq. in. on soft ground. The general military specifications for vehicles of the caterpillar type state that for the future the unit pressure in soft ground with 5-in. penetration shall not exceed 5 lb. per sq. in., a condition which can very easily be met. A study of Fig. 6 will show that when operating on a hard surface, ignoring any raised traction surface or grousers, only that part of the track beneath the truck rollers will provide means of support. As the tractor penetrates soft ground, the area of contact is increased. The sketch illustrates this point for static conditions only, for obviously, if the vehicle moved ahead, unless the ground is unusually springy, the surface would be pressed down so that but little additional contact would be made available at the rear of the track. There is another condition, however, that enters into the problem where the tractor is used for drawbar purposes. The drawbar reaction, as will be shown later, increases the pressure on the rear truck rollers to such an extent that the rear springs are compressed, allowing the rear sprocket to come closer to, or even to touch, the ground, thus increasing the contact area at the rear end.

MARK VIII, A LATE DEVELOPMENT IN TANK CONSTRUCTION

While there are practical limitations in the length of a track due to the effect upon steering, it is very easy not to exceed 5 lb. per sq. in. pressure in soft ground, for after the maximum permissible length of track has been reached, if the ratio between it and the weight to be supported is too high the track can be made of such width that a maximum pressure of less than 3 lb. per sq. in. can be obtained, providing that the slight additional weight is permissible. Taking all the factors into consideration, 4 or 5 lb. per sq. in. pressure is generally satisfactory and is easily obtained.

When low unit pressure is known to be desirable, the question immediately arises as to why the large end sprockets cannot be lowered so as to bring the entire track from center to center of these sprockets in contact with the ground at all times. This would be desirable and is practically the result obtained in soft ground, but on hard surfaces, the laying down and picking up of the track shoes under these conditions creates a mechanical vibration that becomes objectionable at high speed. Even with a very short-pitch track-link, the same condition holds good, whether the track-link is picked up and laid down by the sprocket engaging with the track-link pin, or whether the track rolls around a drum like a belt. Fig. 7 indicates the path of the center of a sprocket where the track is lifted by a sprocket engaging with the pins. Fig. 8 shows the "digging in" action of the end of the shoe when an attempt is made to roll the track around the sprocket drum like a belt. In either event, the necessity of providing clearance at the ends of the track is obvious. Therefore, on a hard surface the real "wheelbase" of a caterpillar vehicle is not the distance from center to center of sprockets but is roughly the center to center distance between the end track rollers.

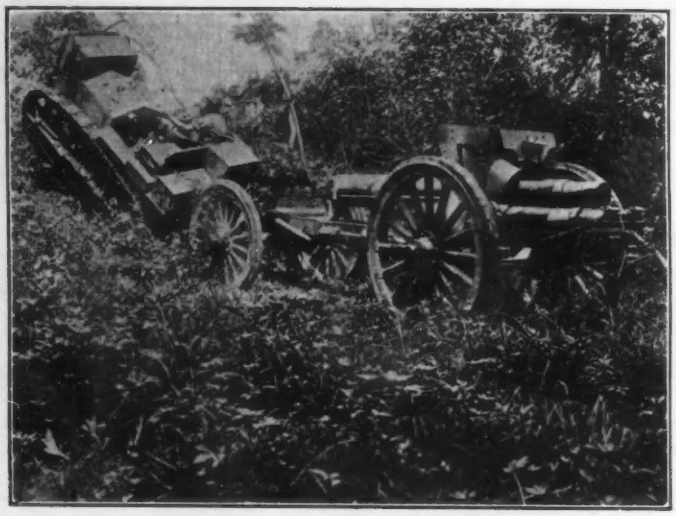
For agricultural purposes, slow speed, over soft going is the usual requirement, but for military and industrial purposes, a possible high speed, approximately 12 m. p. h. or more, is desired. This requirement somewhat complicates the problem, in that such items as unsprung weight, proper spacing of truck rollers, suitable length of track-links, track tension release, etc., assume increased importance.



(From a drawing by Leonardo da Vinci)
FIG. 2—YARD OF A CANNON FOUNDRY OF THE SIXTEENTH CENTURY

Track tension release is accomplished in several ways, but in theory should the track clog up in such a way as to cause a foreign substance of considerable bulk to pass between the truck rollers or the sprockets and the track, some means must be provided to enable the track-supporting mechanism to yield, thus relieving the enormous strain which otherwise is liable to do severe damage. Fig. 9 shows such a condition. Here this strain is relieved by the downward motion of the sprung upper support of the track. This is illustrative of the construction used on the Renault tanks. It is necessary to support the upper part of the track to prevent undue slapping, and advantage is taken of this supporting mechanism to put an arch in the top part of the track, as shown in Fig. 6. The foreign substance passing through the track, as in Fig. 9, creates sufficient tension in the track so that the arch is straightened out, thus allowing the track to leave the sprocket at the rear end as shown.

It is well understood that there is a point at the bottom of a rolling wheel which is momentarily stationary, but it is rather difficult to visualize this fact. This condition is exaggerated in the case of the caterpillar track, as the lower part of the track is stationary with respect



A 2½-TON TRACTOR PULLING A 4.7-IN. GUN AND SHOWING THE NECESSITY FOR THE ENGINE FUNCTIONING ON A STEEP INCLINE

to the ground for a considerable period of time while the top part moves at twice the speed of the vehicle. This acceleration and deceleration of the track in relation to the ground, which is illustrated as a matter of interest only in Fig. 10, does not affect the stressing of the track, except as expressed in the centrifugal force due to the change of direction of the track in relation to the structure itself.

A caterpillar vehicle is usually steered by making one track operate faster than the other or by stopping one track entirely and driving with the other. An idea of the effect of track length on turning can be obtained by reference to Fig. 11.

The most extreme condition is, of course, where one track is stopped and the other side driven. In the sketch the upper track has been stopped entirely and power applied to the lower one, in which case the vehicle will, theoretically, turn on a point beneath the center of pressure on the stationary track, the turning being accomplished by skidding the slowest moving or stationary track about this center.

PROBLEMS OF DESIGN

Without taking time for mathematical proof, it may be stated that for best results the length of the track for tractors should not be more than one and one-half times the tread, or the center to center distance between the tracks. For tanks and other self-propelled vehicles, a ratio of 2 to 1 is permissible.

The ideal proportioning of a caterpillar track can be stated as follows: The shortest possible track shoe to facilitate its being picked up and laid down, the largest possible diameter of truck rollers to negotiate the uneven surface of the track better and reduce rotational speed. The spacing of these rollers should be about equal to the length of the track shoe. This distance should not be exactly equal but varied so that no two rollers will pass over a joint in the track at the same time. These conditions are impossible to meet ideally, as are most other problems in connection with automotive work, so, as is usual in such cases, the solution is reached through compromise, using a little longer track-link pitch and a somewhat smaller diameter of truck rollers. A combination which will operate most satisfactorily to all intents and purposes is one in which the truck rollers are spaced on a center distance of one and one-half times the length of a track-link, the variation of spacing, however, being maintained to avoid any number of rollers passing over track joints at the same time.

A caterpillar track may be likened to that of a railroad made up of very short rails but differs from it in that the rails are located as to position by the wheels of the vehicle instead of being secured to the roadbed. This, coupled with the necessity of what might be termed a positive tractive ability, the driving mechanism, the picking up and laying down of the rails or links, and the necessity of a greater number of smaller wheels on account of the shortness of the rails and the absence of the supporting ties on a graded roadbed, introduce a number of new problems, the more important of which can be listed as follows:

(1) The track material should be easily obtainable, tough and strong to resist wear and rough usage
(2) The track design should lend itself to economical production and assume such form as to readily clean itself of stones and mud
(3) Intelligent reduction of weight of the track-link perceptibly increases the life of the link
(4) The link joints should be made with pins of ample size to require the minimum of lubrication, if any, and to resist the driving loads and stresses caused by the tendency of the track to bend laterally in turning and in negotiating sidehills and rough going
(5) The joints should be arranged so as to avoid any "nut-cracker" effect. The opening and closing of any part of the joint, as the track works back and forth, tends to accumulate and crush small stones and dirt, seriously increasing the stressing of the working parts
(6) The joint in the track rail between surfaces on which the truck rollers operate should be staggered or arranged so as to minimize shocks between the track and the rollers
(7) A reasonable amount of stock and sufficient clearance must be provided to allow for wear on the track rail, due to the action of the truck rollers
(8) It is advisable to load the track near its outer edges rather than at the center, to avoid a side-cocking or twisting action, resulting in undue loading of the track-link pins. This is apparently best accomplished today by the use of a double row of truck rollers. Attempts to compensate the track show that ball joints or hinged connections have not met with much success, owing to clogging up and increased weight
(9) The proper shape or form for the surface which comes in contact with the ground is of great importance, especially for military purposes. It should be arranged so that it will not damage good roads and still make the application of cleats or grousers unnecessary for ordinary soft going. Where grousers are required for maximum perfomance, they should be applicable with the minimum expenditure of time and effort. Some form of easily-applied calks are necessary for negotiating ice
(10) The track drive, necessarily positive, is usually accomplished after the fashion of a block or roller chain and sprocket. Here again care must be used to avoid clogging up with foreign matter, and provision made that the mechanism will clean itself to as great an extent as possible

The caterpillar track-link is a study in itself, about which much can be written. Although in its present state, when made of suitable material and properly designed, it functions most satisfactorily, in long and severe service it presents a very interesting problem, one worthy of the best efforts of the automotive engineer.

Considerable energy is being expended in the development of a combination wheel and caterpillar-tracked vehicle for military purposes; the wheels for high speed and the caterpillar to enable greater load carrying. The results to date are most gratifying, but I cannot help but feel that the ultimate answer for greater speed ranges for heavy-duty purposes will be in a purely caterpillar vehicle with light track shoes, a very small amount of unsprung weight, embodying the use of a considerable quantity of rubber or some other cushioning medium in connection with the rolling members and track.

A military caterpillar vehicle, either for drawbar or load-carrying purposes, should be provided with a four-speed gearbox. The first speed should be very low and give high torque; the second should provide a rate of travel from about 2½ to 3½ m. p. h. at the governed engine speed to harmonize with the rate of travel of a marching column; the third speed which should be from 7 to 8 m. p. h., is to be used as a general traveling speed where there are no special restrictions. This third speed is the maximum rate at which it is considered good practice, in the present state of the art, for caterpillar equipment, and especially the pieces which they now haul, to travel over long distances. An emergency speed of 12 m.p.h., or better, is desirable for short dashes, as for example, where it is necessary to cross quickly places that are exposed to enemy fire, to bring up reinforcements, etc.

I am glad to note a tendency in truck and tractor construction toward lower first speeds. There are still too many who do not appreciate the remarkable advantages of this and its possibilities.

For satisfactory performance, a low emergency speed, giving high pulling power, is essential in any heavy-duty vehicle, for military or industrial purposes, regardless of whether it is a wheel or caterpillar type. Given a vehicle construction with sufficient area of ground contact to negotiate soft terrain, the problem becomes one of providing means for virtually gearing the tractive members to the ground surface. While the caterpillar is rapidly adaptable in this respect, as it permits the engaging of a larger number of cleats or grousers with the surface of the ground at one time, the tractive effort of the mechanism depends largely on the shearing strength of the soil in contact with the tractive member and immediately back of it. To obtain the best results, we are, therefore, confronted with the problem of using, to the best advantage, such strength as is to be found in this particular area of soil. As with any other material, the soil can be safely stressed to a higher degree if the load is applied gradually and uniformly. Careful investigation over a long period of time proves this statement, and it is found that with a very low gear ratio, both wheel and caterpillar types of vehicle have less breakage, require less area in contact with the ground and develop a greater drawbar pull for a given weight. In visualizing this emergency low speed for a military or any other class of heavy-duty vehicle, it should not be looked upon as a means of getting to the destination quickly but rather a provision which will prevent the vehicle being stalled under extreme conditions.

A caterpillar vehicle to operate satisfactorily over very rough going, where it is necessary to climb steep banks, cross ditches, etc., should have no projection outside a plane tangent to the front and rear end of the tracks and sloping at an angle of 60 deg. to the horizontal. It would be very desirable, from one standpoint, especially for military vehicles, to have the tracks extend a considerable distance ahead and behind the chassis; on the other hand, this would increase the weight of the vehicle without proportionate advantage and would probably adversely affect steering conditions to such an extent as to make it undesirable.

Weight is an important factor, especially in regard to vehicles of the lesser capacities, as it is desirable that they negotiate fixed and pontoon military bridges, and

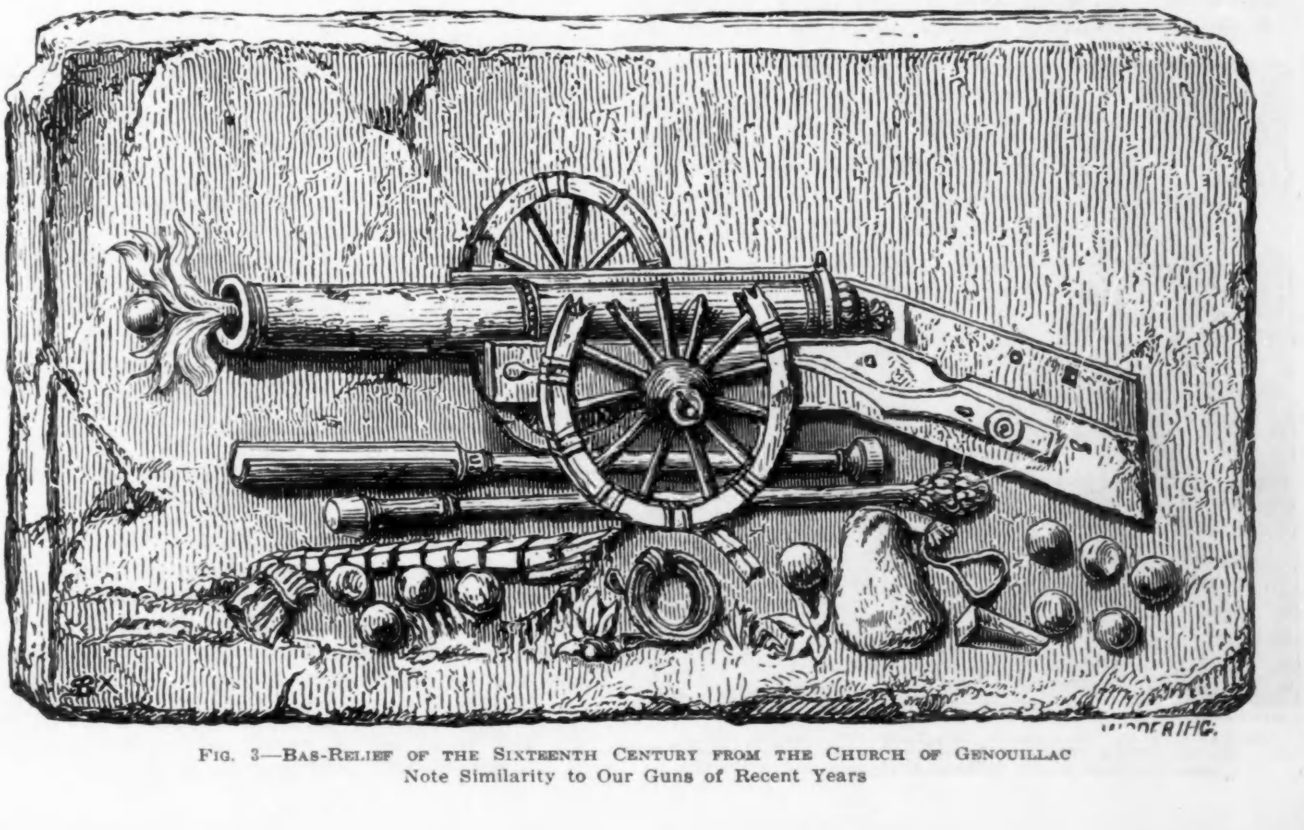
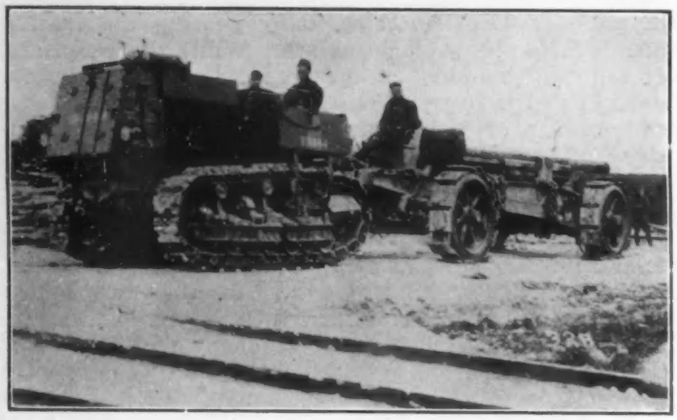


FIG. 3—BAS-RELIEF OF THE SIXTEENTH CENTURY FROM THE CHURCH OF GENOUILLAC
Note Similarity to Our Guns of Recent Years



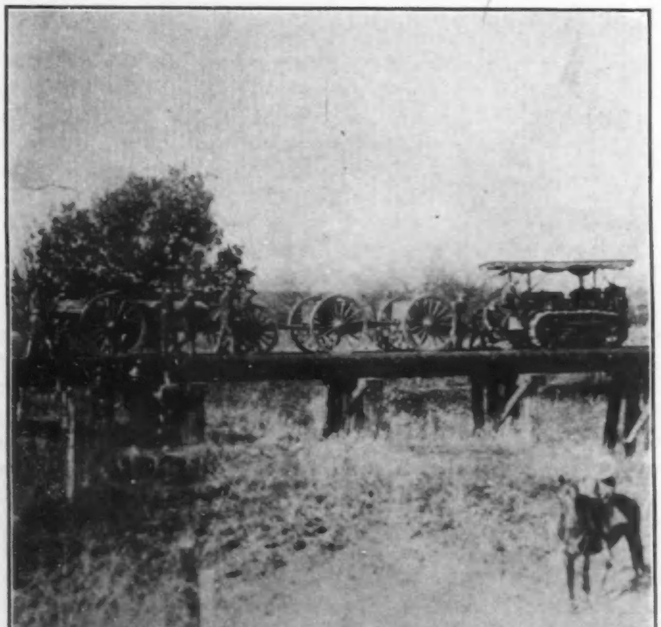
A 10-Ton Artillery Tractor Pulling a 155-MM. Gun

especially the light highway bridges common in this country. The following notes, indicating the different kinds and capacities of military bridges used by our army, are of interest:

(1) Fixed military heavy bridge, both steel and wood. Load, can take Mark VIII tank. Maximum width between curbs 132 in. Height of curb 8 in. Weight of Mark VIII tank 40 tons
(2) Present or intermediate type pontoon bridge, using standard equipment. Load, 5-ton axle loads with 10-ft. minimum separation
(3) Proposed new type of pontoon bridge of about twice the capacity of (2)

One of the great difficulties experienced in the operation of cross-country mechanical transport is in passing through water. This is of such importance that it has been specified that artillery vehicles shall be able to negotiate 5 ft. of water. This problem offers two solutions: that of partially submerging the vehicle and that of floating it. In this connection, it is worthy of note that water was the most effective protection against tanks that was used in the recent war.

The armor problem, from the engineer's standpoint, is more or less simple of solution; for, if the fact that the piece is to be protected is borne in mind, the necessary provisions for doing this can be very readily made.



Adaptability of Tractor to Military Operations Illustrating Good Weight Distribution and Ability to Cross Railroad Trestles Where Horses Could Not Go

One of the most important problems in connection with caterpillar equipment for artillery motorization is undoubtedly that of the proper location of the center of gravity. These vehicles have the ability to negotiate such rough terrain that a tentative military specification today requires that a tractor shall be capable of negotiating a 100 per cent grade without load and shall pull a trailer load equal to its own weight up a 60 per cent grade, if footing can be obtained.

Fig. 12 shows the tractor at rest or running on the level with a slight load. The ideal condition is to have a uniform load on all truck rollers at all times regardless of grade. The law of gravity, of course, makes this impossible. The overturning moment, due to the drawbar pull, is $D \times d$, where D is the drawbar pull and d the distance from the ground to the point of application of the drawbar. The overturning moment, due to the torque reaction and internal friction, which in turn is due to the tractive resistance, is $T \times r$. This resistance T is about 0.08 of the total weight of the tractor and the effective arm r is the radius of the driving sprocket. This makes the total overturning moment $M_o = D \times d + T \times r$. The stabilizing moment $M_s = W \times a$, where a is the horizontal distance from the center of gravity to the plane of the rear roller and W the weight of the tractor. These are the three external forces acting on the tractor and to have equilibrium M_s must be greater than M_o.

Fig. 13 shows the effect of a heavy drawbar pull on the tractor. In this case, the tendency is for the front rollers to lift off the ground and the rear sprocket to come down toward the ground. The stabilizing moment is now increased, its arms becoming a', and the tractor rocks about a point on the ground beneath the rear sprocket instead of about a point beneath the center of the rear roller as shown in Fig. 12. Fig. 14 shows how the stabilizing moment is decreased in ascending a grade. Fig. 15 illustrates the importance of keeping the center of gravity far enough back so that in descending a grade it will not fall outside of the front supporting contact of the track on the ground, in which case the machine is likely to overturn forwardly.

The effect of the height of the center of gravity is also of interest. Assuming the center of gravity to be the distance c from the ground and the angle of the grade α (see Fig. 16) then the moment-arm of the center of gravity becomes, $a \cos \alpha - c \sin \alpha$. From this you will note that as c approaches zero, or comes nearer to the ground, the length of the arm increases. In like manner the distance b (see Fig. 15) may be expressed similarly.

The problem as a whole is one of great magnitude and there is opportunity for application of our best ability to good advantage. In this paper I have merely touched the high spots, but if I have been successful in arousing your interest the desired result will have been accomplished.

Factors to Be Considered

In considering the application of the caterpillar tractor for military purposes, there should continually be kept in mind the fundamental rules affecting quantity production, successful construction and effective design. These may be expressed as follows:

(1) The proportions of the mechanism must be suitable to its use, as nearly correct theoretically as is possible and must function as intended

(2) The design must be such as to simplify the problem of production in every possible respect
(3) The materials used in its construction must not only be satisfactory for their purposes, but such as may easily be obtained in large quantities and uniform quality in times of stress and of such a nature as to be fabricated without undue effort or expense
(4) While original research is recognized as essential and by all means to be encouraged, nothing but thoroughly proved and accepted practice should be considered for production
(5) Interchangeability should be carried to the limit, particularly for military purposes, without, however, jeopardizing the success of the vehicle by imposing impossible requirements. Where possible, there should be interchangeability of units and parts between different *kinds* of vehicle, and as many similar parts as possible in a vehicle should be made interchangeable, thus reducing the number of different pieces.

While the above rules are, of course, familiar to us all, they are repeated because of their prime importance in the design of military equipment, and because it is quite easy for one or more of them to be overlooked in connection with a problem of this kind.

It must be appreciated that the statement that tractors for industrial purposes are not good enough for military purposes is erroneous. The real facts of the case are that any tractor not good enough for military purposes is not good enough for industrial or agricultural purposes.

I believe that the close contact of the automotive manufacturer with the motorization problem in general has given him much valuable knowledge and experience and that in many cases it has undoubtedly improved his product. On the other hand, it is to be hoped that military motorized equipment of all kinds can be developed so that commercial vehicles can, in their turn, be modified to be applicable to the military requirements. This is for two reasons. First, and of greater importance, it is beyond the ability of mankind, in the present state of the art, to develop a new piece of equipment as intricate as the motor car, truck or tractor, build it in quantity and put it into actual service, without going through a difficult and expensive period of learning the problem of production and overcoming unavoidable defects. It is only by putting military motor vehicles into actual production over a period of time that they can be made practically free from weaknesses or, to state it differently, it is only by the use of a commercial product, modified, if you wish, that our Army equipment can be made thoroughly satisfactory from the operation and maintenance standpoints. Second, it has been well proved, during our 18 months of participation in the recent war, that even with the resources of the entire country behind it no factory can be rearranged, tooled up for the production of a newly-designed vehicle and a satisfactory product obtained short of a period of time running into months, and then at an almost unheard-of expense. The use by the Army of vehicles already in production, would therefore make an immediate source of supply available at a much less emergency cost and would not disrupt the industry nearly to the breaking point. This principle is thoroughly appreciated by the Ordnance Department but, at the same time, the problems incident to using commercial vehicles for war purposes have seemed almost unsolvable.

The Ordnance Department, during the period of our participation in the war, used engines in some of its vehicles which conformed to the specifications given in

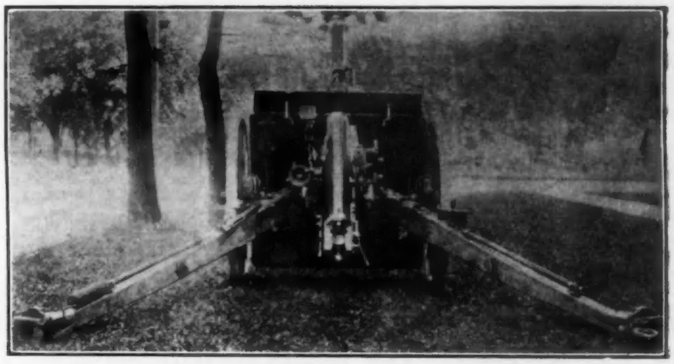


FIG. 4—1913 MODEL OF 3-IN. GUN
While fundamentally the same as the earlier guns note great improvement in construction and means of control

Table I. It has plans for the future which, when put into effect, will ultimately replace the present engine equipment with a series of powerplants, which it is estimated should be about as follows:

(1) A 60-hp. engine for use in 2½ and 5-ton tractors, self-propelled gun mounts and cargo carriers of corresponding capacities. The reason for the relatively less horsepower in the 5-ton tractor as compared with the 2½-ton unit, is that it is assumed to be a slower speed vehicle
(2) A 120-hp. engine for use in 10 and 15-ton tractors and any self-propelled gun mounts or cargo-carrying vehicles of like capacity, the loaded weight of which does not exceed 50,000 lb.
(3) Engines of 350 to 400 hp. for use in the heaviest types of tanks

These capacities are, of course, only estimates, but they give some idea of the tendencies in future military engine requirements.

CONCLUSION

This industrial problem and the other engineering problems are a few which are laid before you for solution. Can the military engineers modify their requirements and plans to meet a possibly modified method of procedure of the manufacturers, or can some scheme be developed whereby these two groups can get together in producing and using a commercial line of vehicles and units? Is it possible to take the design of an engine already in existence, or is it better to design a new one and to attempt to interest manufacturers to take it up and gradually put it into use in order that the type, size and design of engines may be consistent?

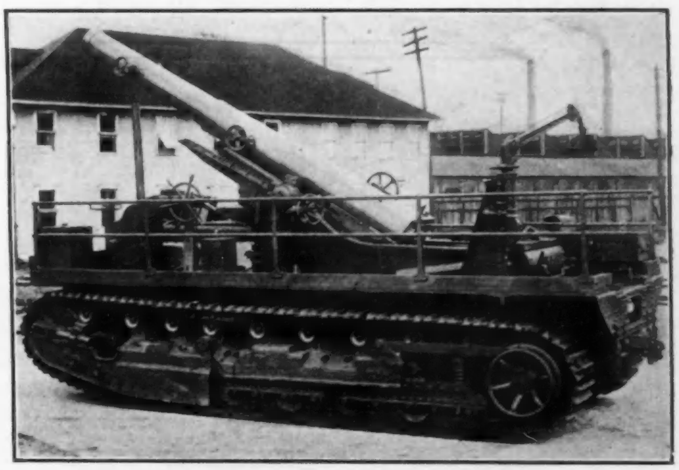


FIG. 5—LARGE HOWITZER ON SELF-PROPELLED CATERPILLAR MOUNT, THE VERY LATEST DEVELOPMENT IN MOBILE ARTILLERY

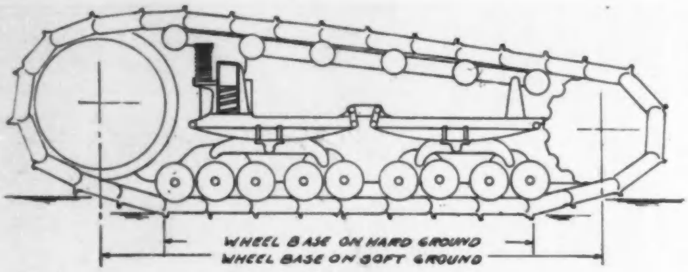


Fig. 6

In any event, existing equipment must be modified to meet desired operating conditions, future possibilities and peace-time requirements better. This existing equipment must be studied over a period of time; it must be revamped and in some cases entirely redesigned in order that it may be produced more efficiently and fit in with the producing conditions of the automotive industry.

Congress must provide the authority and the means whereby this most necessary work can go on. Large sums of money and great engineering effort are expended annually by many of our large manufacturing concerns in the improvement and the development of a single product. Obviously, it is necessary for the Government to go to greater extremes in carrying out this important motorization movement, because in this there will be no direct competition to act as a stimulus and others will not undertake or continue the work if the Government does not.

The Society has been requested, and has already appointed, a committee of seven members to advise with the technical staff of the Ordnance Department.

It is hoped that those of you who have been active in similar work during the war will continue to give thought to the solution of the problems here outlined, and that others will also become interested to the end that all of us shall give our best efforts and moral support, as has been requested for the furtherance, not only of this most important military project, but also for realizing the commercial advantages that will evolve from it.

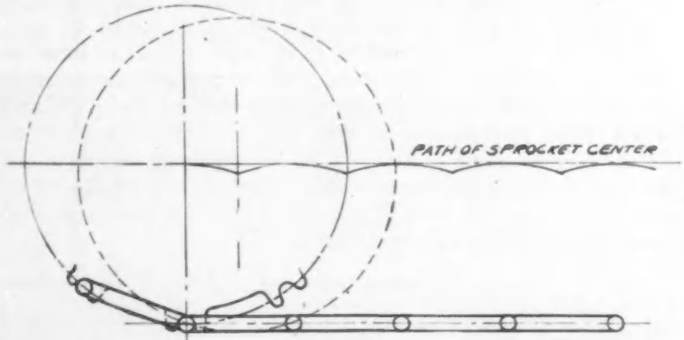


Fig. 7

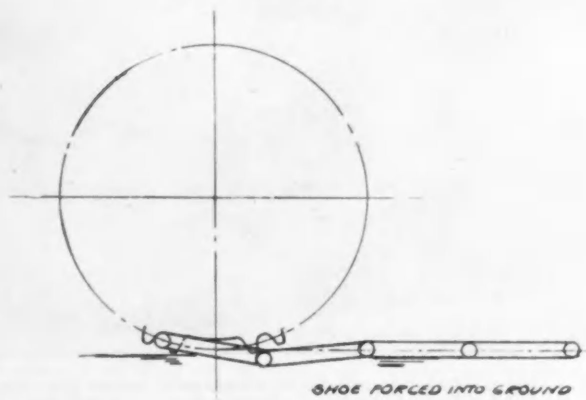


Fig. 8

Let us apply to the solution of this big problem the same enthusiastic energy that was applied to the winning of the war, so that our country, through the cooperation of its automotive experts with its ordnance engineers, shall continue to lead in the art of cross-country mechanical transport.

Appendix

The Westervelt Board, so called after its senior officer, Brigadier-General W. I. Westervelt, consisted of a group of seven Army officers appointed Dec. 11, 1918, to make "A study of the armament, calibers and types of material, kinds and proportion of ammunition, and methods of transport of the artillery to be assigned to a field army."

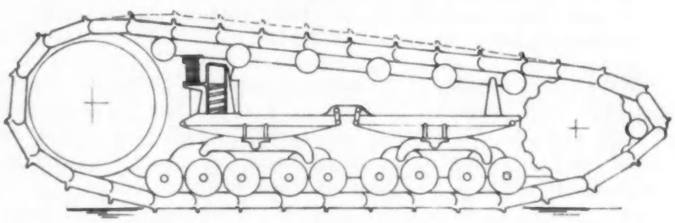


Fig. 9

After a thorough investigation, both in this and certain Allied countries, the report of its findings was made at Washington, May 5, 1919, and approved by the Chief of Staff on May 23, 1919.

The war has brought about no radical changes in motor cars. About the most that can be said on this subject is that certain commercial cars have shown greater strength of parts and ease of operation than others. They are, therefore, favored for military purposes.

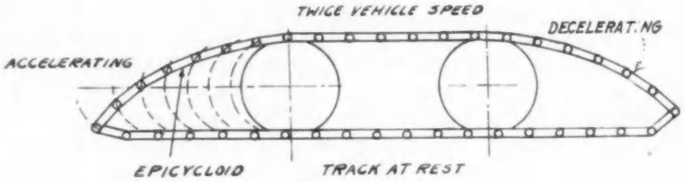


Fig. 10

When motor trucks were first used for military purposes the commercial types were naturally used. The two-wheel-drive type was the first to appear; later, to meet a demand for utilizing to the best advantage the full power, the four-wheel-drive type made its appearance in the commercial world. When the two types were tested in the early days of the Mexican expedition,

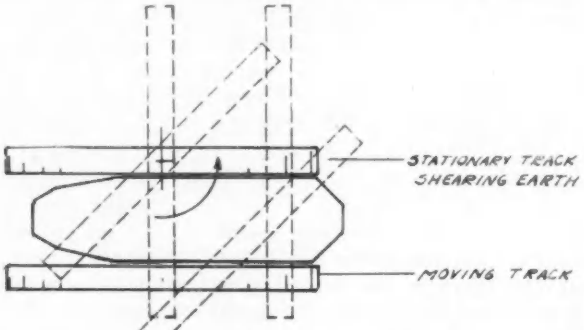


Fig. 11

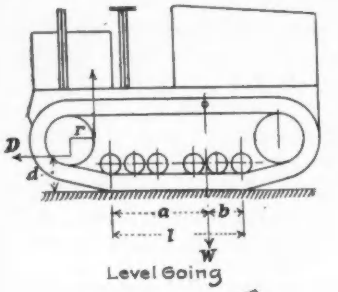


FIG. 12

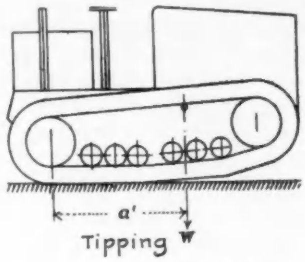


FIG. 13

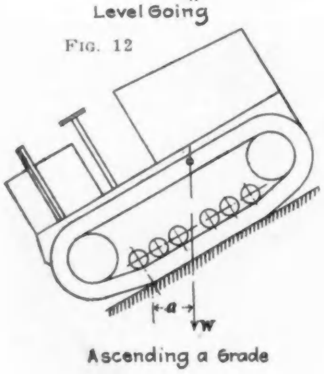


FIG. 14

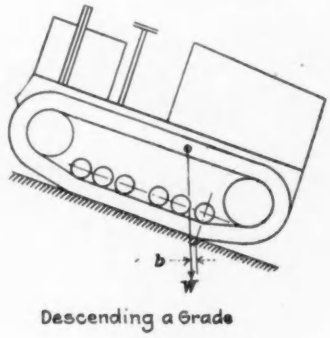


FIG. 15

In tipping the moment arm of the center of gravity increases
In ascending a grade the moment arm of the center of gravity decreases
In descending a grade the machine will overturn when $b = 0$
D = Drawbar
d = Distance between the ground and the drawbar or 28 in.
t = Reaction due to tractive resistance
r = Radius of the driving sprocket
W = Weight of the machine
a = Distance from the rear axle to the center of gravity
b = Distance from the front axle to the center of gravity
l = Wheelbase
M_o = Overturning moment $= D \times d + t \times r$
M_s = Stabilizing moment $= W \times a$
$M_s > M_o$

real dependence was placed on the four-wheel-drive trucks, there being instances where whole trains of two-wheel-drive trucks were stalled. At a later date when the roads had dried and improved, the two-wheel-drive type made a better showing and came out with a better reputation.

However, the artillery is most interested in the type of truck that is best suited for bad road conditions. The United States Marine Corps, which has had to use motorized field artillery for some of its minor operations, adopted, after many tests, the four-wheel-drive truck to handle its artillery. Throughout the entire war the English, French and Russian governments, purchased considerable numbers of trucks driven on all four wheels, for use in their artillery service and, as late as July, 1918, the French made an urgent demand on the American Expeditionary Force for 300 such trucks. The four-wheel-drive truck has such power, application and weight distribution, as to assure movement of the vehicle if traction can be obtained even by one wheel.

Up to the fall of 1917, there had not been found a type of four-wheel-drive truck as refined in mechanical detail as some of the higher types of two-wheel-drive trucks. This was natural, as the development of the four-wheel-drive came later than that of the two-wheel-drive truck. However, the Ordnance Department undertook the development of a four-wheel-drive truck that would not have any of the defects of the four-wheel-drive commercial types. This truck was ready for production in May, 1918, and was recommended by a board of officers from practically every department of the service for adoption as the standard type of four-wheel-drive truck for the United States Army (see paragraph 30, War Department Special Order No. 91, dated April 18, 1918).

In the opinion of the board, the four-wheel-drive two-wheel-steer type of truck is the only heavy cargo carrying wheeled vehicle which is adequate to meet artillery needs in the battery, battalion and the regiment as well as in the artillery ammunition train, and until a definite recommendation to this effect is approved, the artillery arm will be burdened with a heterogeneous mass of trucks whose use is confined almost entirely to good roads.

The following are certain extracts from the report mentioned on the preceding page which are of interest as bearing on the subject of this paper:

Mechanical transport is in such a state of development in this country that there is no need in dwelling upon its numerous advantages over animal draft. It is, however, pertinent to give a brief outline of the extent of its employment by foreign governments, while stating that the United States is far in advance of all other world powers in respect to self-propelled vehicles as applied to artillery transport

German Wheeled tractors of the farm and road repair type, with low speed, great power and extreme weight for hauling heavy weapons. Wheeled trucks of the two-wheel-drive type with medium speed, medium power and normal weight, carrying anti-aircraft guns, directly and permanently mounted upon the chassis

Italian Wheeled trucks, similar to the German vehicles as anti-aircraft gun mounts. Wheeled tractors of two-wheel-drive type, medium power, speed and weight for hauling heavy weapons

British Rear - wheel - drive trucks, four - wheel - drive trucks and a limited number of the heaviest American commercial farm caterpillars for hauling heavy weapons

It is noted that these three nations confined themselves, for the most part, to wheeled vehicles, which at once limits mechanical artillery transport almost entirely to good roads.

French While using four-wheel-drive trucks of great power and mobility throughout the war, the French finally recognized, in 1917, the necessity and advantage of cross-country mechanical transport as evidenced by their development of platform caterpillars for carrying their 155-mm. howitzer mounted on its wheeled carriage, and for towing other heavier weapons; of cargo-carrying caterpillars for ammunition and other supply purposes; and of self-propelled caterpillar gun mounts for heavier guns.

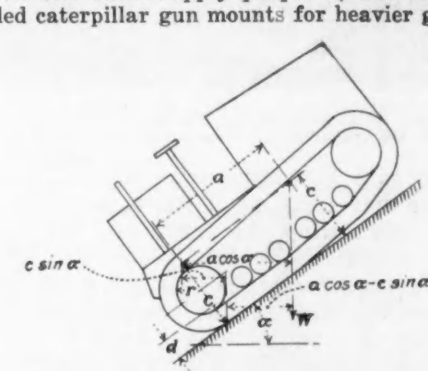
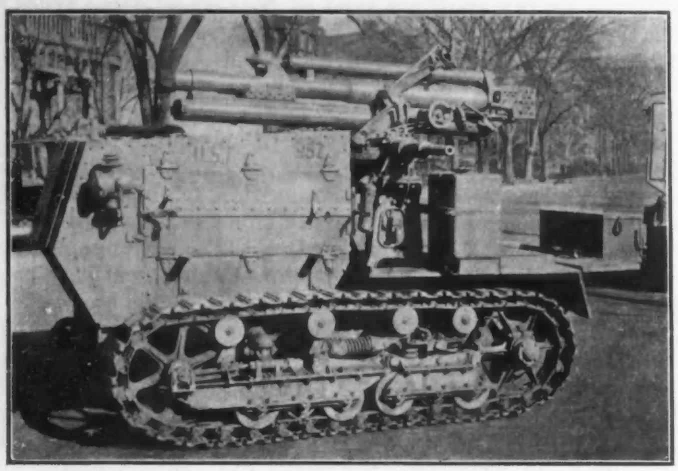


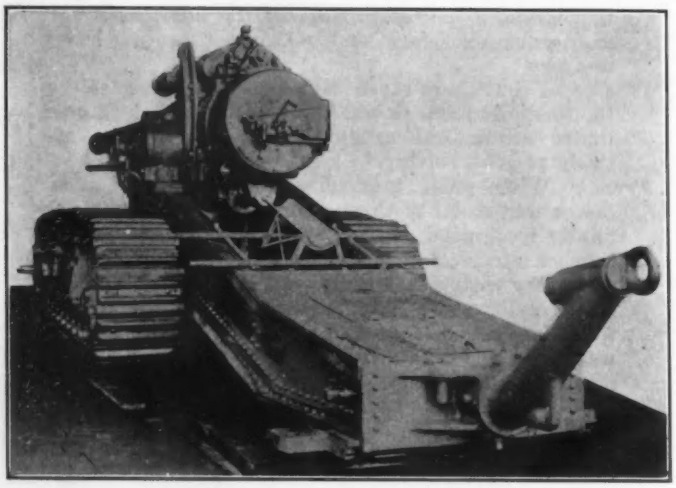
FIG. 16

Component of W along plane $= W \sin a$
Maximum drawbar pull on the level $= 0.8\ W$
Maximum drawbar pull on a grade $= 0.8\ W - W \sin a = W\ (0.8 - \sin a)$
Stabilizing moment $= W\ (a \cos a - c \sin a)$
Overturning moment $= W\ (0.8 - \sin a)\ d + 0.08\ Wr$
$W\ (a \cos a - c \sin a) > W\ (0.8 - \sin a)\ d + 0.08\ Wr$



READY ADAPTATION OF 75-MM. GUN TO 5-TON TRACTOR MOUNT

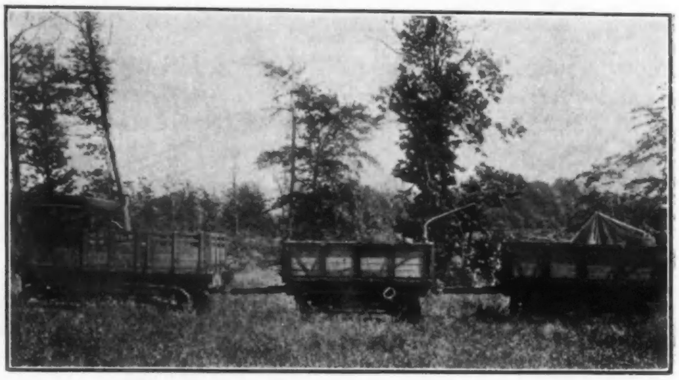
The superiority of the caterpillar over all other mechanical prime movers across country may be realized when we consider the essential features embodied in its construction. The frame supporting the powerplant with the necessary power transmission members is mounted upon small wheels. These wheels, instead of making direct contact with the ground, travel continuously upon a track, the rails of which are permanently mounted upon a flat, broad surface. This surface of tread corresponds with the sleepers or cross-ties of the railroad and is of such width as to secure very low unit pressures upon the ground. The track with its tread is formed into an endless belt which is driven by a sprocket identically as is the bicycle chain. The whole vehicle, therefore, may be said to constitute a wheeled mechanism which lays its own track as it moves over the ground. Further, by articulating the track and the frames or trucks which mount the wheels, accurate conformation to the varied ground surface is obtained, a feature which further insures traction. Again, the power is applied in such a manner that an individual drive is assured on each of the two tracks. With such a structure, movement is assured over very soft ground owing to low unit pressure, which is usually about 5 lb. per sq. in. The caterpillar can span wide gaps or ditches, or climb steep slippery grades. The grip on the ground or traction is secured by cleats or grousers which project to a height of approximately 3 in. from the surface of the treads.



A 7-IN. NAVAL GUN ADAPTED TO CATERPILLAR TRUCKS MAKING TRANSPORTATION OFF ROADS POSSIBLE

With the grousers removed the caterpillars do not seriously damage hard roads. The above advantages make the caterpillar the only logical prime mover to replace the team in draft.

The progress in artillery motorization is best indicated by the recommendations and results obtained by boards of artillery and ordnance officers. These recommendations were arrived at after long, careful study, test and investigation, not only in the laboratory but also in the field under simulated and actual war conditions. The authority in each case is given, together with the substance of the recommendation of the various boards.



TRACTOR CAISSON PULLING CARGO CARRYING TRAILERS WEIGHING 3 TONS EACH

Paragraph 51 of War Department Special Order No. 98, 1917, appointed a board to "consider the question of motor traction for field artillery." This board recommended

(1) Motorization of the 4.7-in. gun
(2) Motorization of the 8-in. howitzer
(3) Use of rubber tires on all field artillery material
(4) Formation of a pool of 30 artillery tractors for each combat division
(5) Sending a member of the board to France to investigate the motorization of the 6-in. howitzer.

These recommendations were approved by the Secretary of War, and the several supply departments were directed to put them into effect.

The result of the investigation in France was paragraph 7, Special Order No. 83, General Headquarters, A. E. F., 1917, appointing a board to "consider and report upon the question of motor transportation for 6-in. howitzer material."

This board recommended

(1) Motorization of the 6-in. howitzer
(2) Retention of the divisional tractor pool
(3) Development of motor transport for artillery in all forms

MILLING MACHINE TRAILER, ONE OF THE MANY VEHICLES COMPOSING A HEAVY ARTILLERY MOBILE REPAIR SHOP COMPANY

GENERAL SPECIFICATIONS

Vehicle	Draw-bar Pull, lb.	Cargo Capacity, tons	Speed, m.p.h. Minimum	Speed, m.p.h. Maximum	Application	Remarks
Caterpillar Tractors						
Tractor cart[4]	....	1/10	1	4	Wire reels; heavy machine guns; infantry accompanying gun	Operated by man on foot
Tractor[4]	....	1/4	3	12	Miscellaneous pack transportation; heavy machine guns; mountain guns; replaces horse for individually mounted men; wire reels	Replaces riding horse of individually mounted man
Tractor[5]	4,000	2½	3	11 to 12	75-mm. gun; light field howitzer; reel carts	
Tractor[5]	7,000	5	3	8	155-mm. howitzer; 4.7-in. gun; 9.2-in. and 240-mm. howit , zer, breaking into 3 loads	
Tractor[6]	10,000	10	3	6	8-in. howitzer; 155 G. P. F.; 9.2-in. and 240-mm. howitzer, breaking into 3 loads; salvage	
Tracto [4]	15,(00	15	1	5	5-in. and 6-in. seacoast and 194-mm. guns; salvage	
Tractor caisson, Mark VII[5]	....	3½	1½	4	Ammunition transport with battery; 155 G. P. F. tractor hauled or tractor mounted; army artillery	Replaces caissons in heavy batteries
Tractor caisson, Mark VIII[6]	....	5	....	....	....	Not thought practicable, due to exce sive weight
Trailers						
Caterpillar trailer[5]	....	3	....	....	Ammunition transport with battery; 4.7-in. and heavier guns; howitzers	Replaces caissons in medium heavy batteries
Light caterpillar trailer[4]	....	1½	....	....	Ammunition transport with battery; 75-mm. gun; light field howitzer	Replaces caissons in division artillery
Wheel Type Vehicles						
Ordinary standard four-wheel drive[6]	8,000	3	3	12	Army and corps artillery; all uses	
Light four-wheel drive[4]	....	1 to 1½	3	15	Divisional artillery; all uses, including ammunition trains	
Heavy motorcycle with sidecar[5]	....	1/4	3	50		
Trailers						
Trailer[6]	....	3	....	....		
Trailer[6]	....	4	....	....		
Trailer[6]	....	10	....	....	....	Transport of 10-ton tractors, etc., in heavy batteries

[4]Proposed.
[5]Under test and developing.
[6]Adopted.

These recommendations were approved by the Commander-in-Chief, A. E. F., in paragraph 15, cablegram No. 149, to the Adjutant General, Sept. 11, 1917, and the supply departments were directed to comply.

Paragraph 69, War Department Special Order No. 242, 1917, appointed a board to continue the work of the field artillery motor-traction board "to consider all questions of motor traction for field and heavy artillery."

This board recommended the motorization of

(1) The 6-in. howitzer
(2) The 4.7-in. gun
(3) The 9.2-in. howitzer
(4) The 240-mm. howitzer

The board further recommended

(1) Use of wheeled trailers in certain motorized organizations for rapid transport of the tractors
(2) Use and general requirements of the staff observation and reconnaissance cars

These recommendations were approved by the Secretary of War, and the supply departments were directed to take the necessary steps to comply therewith.

Based upon data collected by the above boards, the General Staff drew up tables of organization for motorizing the 155 G. P. F., and the 5 and 6-in. seacoast converted guns.

An artillery board at General Headquarters, A. E. F., after practical test recommended

(1) Motorization of 50 per cent of the 75-mm. gun regiments in each division
(2) Motorization of the caisson companies of the ammunition train

These recommendations were approved by the Commander-in-Chief, A. E. F., in paragraph 1, cablegram No. 1771, Oct. 9, 1918.

Weapons of various sizes have also been placed on experimental self-propelled caterpillar mounts, namely, the 75-mm. gun, the 155 G. P. F., the 8-in. and the 240-mm. howitzer.

The Heat-Treating of Brazed Fittings for Aircraft

By ARCHIBALD BLACK[1] (*Member*)

AERONAUTIC MEETING PAPER *Illustrated with* CHARTS

A TENDENCY exists in most shops to assume that brazed joints cannot be successfully heat-treated. As a consequence, many fittings used in aircraft work and assembled by brazing smaller parts together are finished and installed without being heat-treated after the brazing operation. This practice causes parts to be used that not only do not develop the available strength of the material, but which are even, in some cases, under internal stress due to the heating in the brazing operation. It has been shown by some recent experiments, made at the Naval Aircraft Factory, that this assumption is entirely erroneous. It is therefore advantageous to consider this matter with a view toward specifying the use of steels and brazing spelters which will permit the subsequent or perhaps the simultaneous heat-treatment of the parts.

MATERIALS

Considering the spelters required for such work, it is necessary to know not only their melting but also their approximate softening points, to avoid the destruction of the brazed joint during heat-treatment. Fig. 1 gives the approximate melting points and tensile strengths of several different compositions which provide a wide range for selection. These values are, however, subject to slight modification, due to the presence of some 1 to 1.25 per cent of impurities in commercial spelters, yet for the purpose of this work they may be considered correct, and it is recommended that the curve of tensile strength of cast material be assumed correct for the strength of the spelter in a brazed joint.

More detailed information of the properties of spelters is given by Hofman[2]. Information about softening points is not so definite. Something can be learned from the equilibrium diagram for brasses given by Hofman,[2] and also from a test made by the Naval Aircraft Factory which showed that a brazing wire of 80-20 brass mixture appreciably softened at about 50 deg. fahr. below its melting point.

[1]Engineer in charge of aeronautical specifications, Bureau of Construction and Repair, Navy Department, Washington.
[2]Metallurgy of Copper, Hofman.
[3]Notes on the Critical Ranges of Some Commercial Nickel Steels, Scott, *Mining and Metallurgy*, February, 1920.

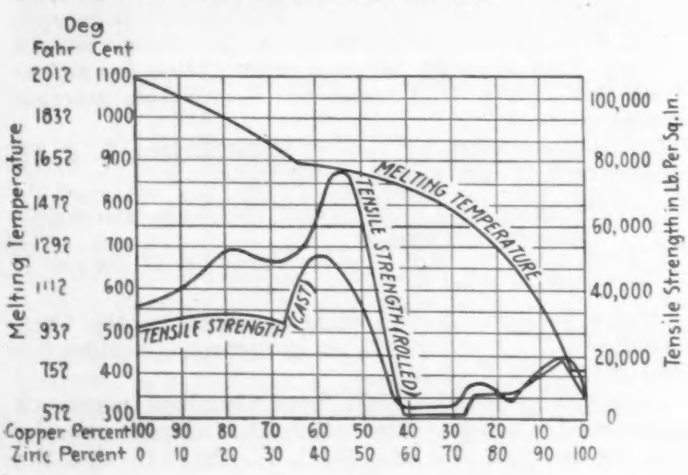


FIG. 1

Considering the steels likely to be required for the

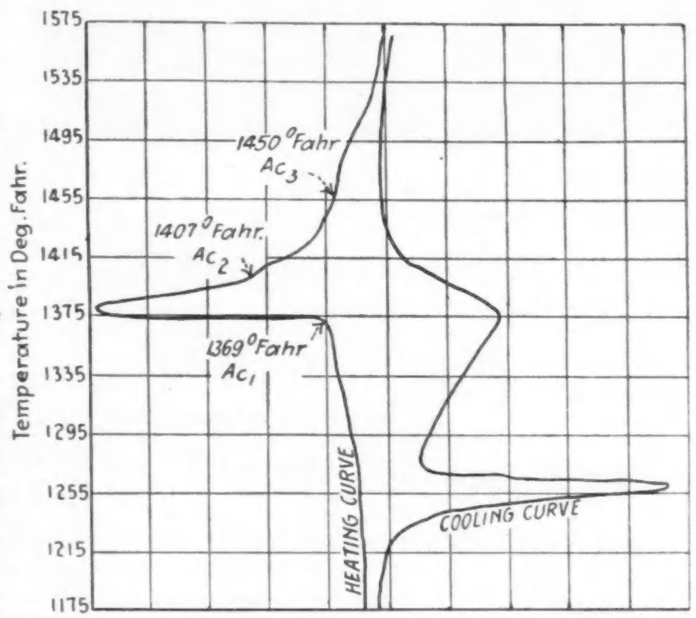


FIG. 2

construction of aircraft parts, by consulting specifications issued by the Air Service and by the Bureau of Construction and Repair of the Navy Department, it is found that a typical list such as that given in the accompanying table can be compiled. This table is reproduced from aeronautical specification No. 89a of the Bureau of Construction and Repair, Navy Department, for the heat-treatment of brazed joints and is based upon work done by the division of metallurgy of the Bureau of Standards.

As is well known, when steels are heated or cooled, irregularities in the rise or fall of temperature take place at certain periods, indicating internal changes in the material. These so-called critical points are actually short ranges but are known in steel technology as the Ac_1, Ac_2 and Ac_3 points where they occur during heating and the Ar_3, Ar_2 and Ar_1 points where they occur during cooling. Fig. 2 is a typical heating and cooling curve, showing the transformations for a steel of 0.3 per cent carbon and 0.7 per cent manganese, and Fig. 3 is the "equilibrium diagram"[3] for straight carbon steels and is correct for 0.05 to 0.80 per cent carbon, at temperatures of 700 to 950 deg. cent., the critical points being clearly shown. Such diagrams are usually only approximate, however, as they are affected by the impurities always

TYPICAL LIST OF STEELS USED IN AIRCRAFT WORK, WITH THEIR APPROXIMATE PROPERTIES

Steel	End of Upper Critical Range on Heating, deg. fahr.	Heat Treament: Hardness After Oil Quench			After Heat Treatment: Hardness		Tensile Test		
		Brinell	Shore Scleroscope	Drawing Temperature, deg. fahr.	Brinell	Shore Scleroscope	Ultimate Strength, lb. per sq. in.	Yield Point, lb. per sq. in.	Elongation in 2 in., per cent
Mild carbon (0.15 to 0.35 per cent carbon),	See Fig. 3	150 to 225	30 to 40	800 to 1,300	180 to 130	30 to 20	90,000 to 60,000	60,000 to 40,000	18 to 26
Medium carbon (0.35 to 0.55 per cent carbon),	See Fig. 3	225 to 325	40 to 55	700 to 1,200	250 to 180	40 to 30	110,000 to 90,000	80,000 to 60,000	16 to 20
High carbon (0.55 to 0.75 per cent carbon),	See Fig. 3	325 to 380	55 to 70	250 to 1,000	325 to 250	65 to 40	160,000 to 125,000	125,000 to 90,000	2 to 10
High carbon (0.75 to 1.05 per cent carbon),	See Fig. 3	380 to 420	70 to 90	250 to 1,000	400 to 325	90 to 65	250,000 to 160,000	200,000 to 125,000	2 to 10
Nickel (0.20 per cent carbon, 0.50 to 0.80 per cent manganese, 3.25 to 3.75 per cent nickel),	1,390 to 1,330	350 to 550	50 to 80	900 to 1100	275 to 200	44 to 34	140,000 to 108,000	110,000 to 78,000	20 to 25
Nickel (0.40 per cent carbon, 0.50 to 0.80 per cent manganese, 3.25 to 3.75 per cent nickel),				600 to 900	400 to 295	60 to 44	215,000 to 155,000	190,000 to 130,000	12 to 16
Low nickel chromium (0.35 to 0.45 per cent carbon, 0.50 to 0.80 per cent manganese, 1.00 to 1.50 per cent nickel, 0.45 to 0.75 per cent chromium),	1,385	400 to 600	60 to 100	700 to 1,100	360 to 245	60 to 42	204,000 to 112,000	168,000 to 94,000	10 to 17
Chromium-vanadium (0.35 to 0.45 per cent carbon, 0.50 to 0.80 per cent manganese, 0.80 to 1.10 per cent chromium, over 0.15 per cent vanadium).	1,425	400 to 600	60 to 100	800 to 1,400	440 to 210	60 to 25	220,000 to 105,000	190,000 to 65,000	10 to 20

found in commercial steels. An extended discussion of the heat-treatment and metallography of steel will be found in Sauveur,[4] Bullens[5] and other standard works on this subject.

In the heat-treatment of a steel it is necessary to quench it from a temperature slightly above the upper end of its higher critical range, the actual temperature depending largely upon the size of the part being treated. As a general rule this temperature should be at least 50 deg. fahr. above, and if information is not at hand concerning quenching temperature, it is advisable to consult the steel manufacturer for advice on the entire heat-treatment, rather than to attempt any experiments. The Midvale Steel & Ordnance Corporation issued a booklet containing much information about its series of alloy and tool steels, which is of general value. If the parts are to be brazed and heat-treated, a spelter should be selected such that the quenching temperature of the steel employed will be at least 125 deg. fahr., that at which the brazing spelter melts, and, if possible, this difference should be greater to avoid danger of destroying the brazed joint during heat-treatment.

Heat-Treatment

If the parts are to be brazed first and heat-treated in a separate and subsequent operation, the two operations can be handled in the usual manner, except that it may be found necessary to take special precautions to avoid warping during heat-treatment. It would seem advisable, however, to rivet, spot-weld or otherwise fasten the parts together before brazing, so as to prevent trouble from slippage of the joints during the subsequent heating. This practice of fastening parts together before brazing is in use in many shops at present and has been found to facilitate rather than to hold up production in most cases. Boulton[6] gives a detailed discussion of brazing.

The operations of dip brazing and heat-treating can be combined by selecting steels and brazing spelters which have the necessary quenching and melting temperatures respectively. In this method the brazing spelter should be maintained sufficiently above the specified quenching temperature of the steel to insure quenching at the proper point. If possible, a brazing spelter should be selected which has a melting point sufficiently above the specified quenching temperature of the steel to per-

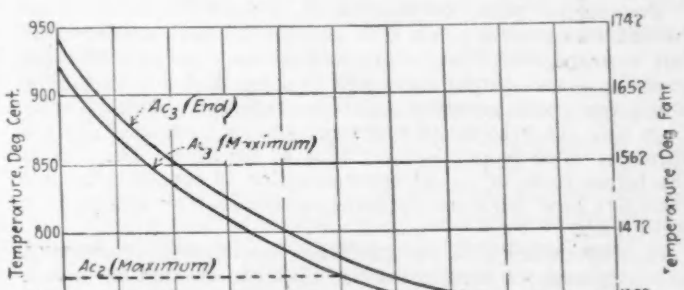


Fig. 3

[4] Metallography and Heat-treatment of Iron and Steel, Sauveur.
[5] Steel and Its Heat-treatment, Bullens.
[6] Brazing, Welding and Soldering in Aeroplane Construction, Boulton, *Aerial Age*, Oct. 6, 1919.

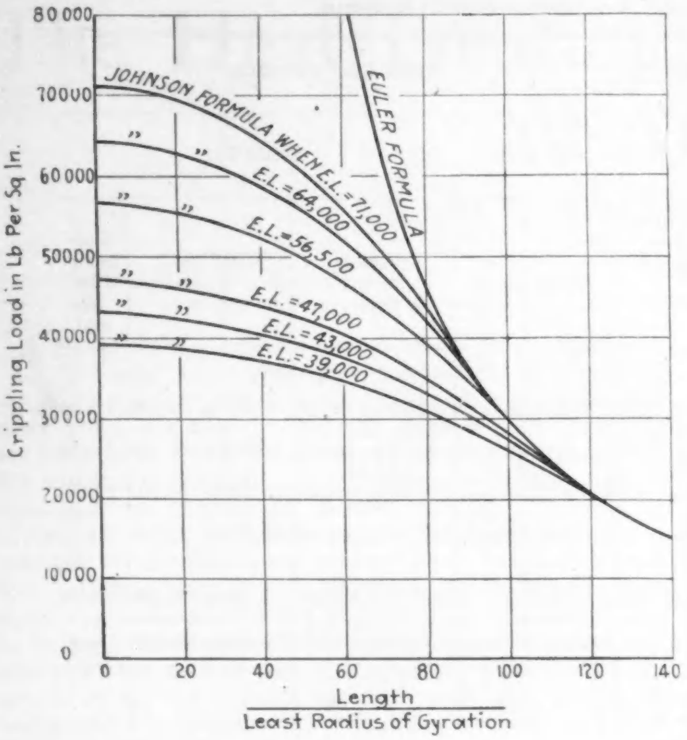


FIG. 4

mit the practice of allowing the brazing to set slightly before quenching. If, however, the temperature of the brazing pot is allowed to approach 1750 deg. fahr., the composition of the spelter will be subject to a gradual change, due to the rapid volatilization of the zinc, with a resultant rise in its melting point. The parts should be allowed to remain in the pot sufficiently long to raise the temperature of all of the material to that of the spelter and should then be withdrawn and immediately quenched in accordance with the instructions of the heat-treatment being used. The reheating and drawing operations can then be followed in the usual manner.

As the combinations of processes described are new to the workmen, it is very advisable to proceed with caution in attempting to introduce them into the shop. Once the workmen become familiar with the methods and the proper materials have been determined and obtained, they possess considerable advantage in permitting the designer to make use of the important gain in strength due to heat-treatment, with the consequent lightening of the larger parts.

NOTES ON TUBES

It is well to mention, however, that no material advantage will be gained by heat-treating many of the tube struts or frames used in aircraft work, inasmuch as these are loaded as columns when in service. An examination of Euler's formula for crippling loads of long columns will show that the strength of such columns is determined by the form of the column and the modulus of elasticity of the material used, the strength of the material not entering into the equation. Many tests have shown that the modulus of elasticity of steel is practically unaffected by heat-treatment, in addition to varying but little with great differences in the chemical composition. Thus, for example, a strut of heat-treated alloy-steel tubing will cripple at practically the same load as a strut of the same dimensions but of annealed low-carbon steel, providing (*a*) that the slenderness ratio is sufficiently high to justify the use of Euler's formula, and (*b*) that the ends are designed to transmit the loads without local failure. Fig. 4 shows the graph of Euler's formula, together with the graphs of Johnson's formula for various elastic limits, corresponding to different steels, and illustrates very plainly that nothing is gained by the use of high-strength steel where the length divided by the least radius of gyration exceeds about 100.

FINANCIAL ASPECT OF COMMERCIAL AVIATION

THE experience of the last twenty or more years in the practical operation of lighter-than-air craft in Great Britain, France, the United States and Germany makes it possible now to analyze readily the financial aspects of the application of airships to commercial aerial transportation. The tables of operation costs, income and capital investment are now available and reveal many interesting features contradictory to hitherto generally accepted prejudices on the subject of aviation finances.

Commercial aerial transportation is something that cannot be undertaken on a small scale and put through successfully; but a proposition that is financed so that it can suffer improbable losses at the start will survive, and within a relatively few years promises a greater return per unit of value than any other so-called "new proposition" successfully put through. This is particularly true of airships. The risk in the latter form of aerial transportation is considerably less than has been heralded by many, unfamiliar or antagonistic to its uses.

It is estimated that the minimum capitalization necessary, to inaugurate an airship service that can be said to have a sufficiently safe margin to be designated as rightly conservative in the light of these facts, would be $5,000,000 for the operation of two small airships; small in the sense of size, yet large in type, assuming that they will be non-rigid. The operation of these craft is assumed, with proper and necessary equipment, over an efficient route range for this type of craft of between 800 and 1000 miles. This sum bears a larger percentage of ground costs than any other further expansion or increase in operations will bear.

An estimate of the cost of operations for airships can be based upon performance data of over 2,500,000 miles covered, equal to more than one hundred times around the earth at the equator, and will include depreciation, running costs, upkeep, ground costs, insurance, etc. Estimates based upon these data cannot be far from right and if computed with a proper margin of allowance will not exceed a value of greater than 15 per cent of the total capitalization. This rate, with added experience and the efficiency inherent to large-scale expansion, will be reduced materially.

A computation of commercial rates sufficient to cover total annual charges, and still repay the sources of financial supply a reasonable return even at the start, other data remaining equal, has been made by both American and English authorities and put at eight cents per passenger-mile. Considering that the transportation provided accomplishes the distance between any given points in one-half the time that direct railroad connections would take at a total cost averaging five cents per passenger-mile, thereby supplying speed, one of the most necessary elements to present progress, it seems that this rate and the patronage which it will unquestionably draw is ample proof of the immediate practical adaptability of airships to commercial aerial transportation.—Air Service News Letter.

The Place of the Section in Society Activities

By C. F. Clarkson[1] (*Member*)

INDIANA SECTION ADDRESS

It is a real pleasure to be here, on account of the spirit of the Indiana Section. The Indiana Section is famous. The call of Indiana is familiar to us all. The strong individuality of the Indiana Section is a real thing; and the character and the appeal of the members of the Section also are great.

As to the Sections of the Society, which is my topic this evening, I am very glad to talk. The Sections are very largely the life blood of the whole fabric and organization of the Society. They are the typification and the exemplification of the activities of the Society, through participation in the various kinds of work the Society is doing, and in large part in carrying forward the enthusiasm we always have at the Summer and Winter Meetings of the Society. At the Summer Meeting that enthusiasm is not only remarkable, but never waning, and increasing, I am very glad to say. The Sections carry that spirit forward very well indeed.

The Local Value of a Section

The Sections are of the utmost value continuously, in a local way, both professionally and socially, and also to the members at large who receive in due course through the publications of the Society the papers and discussions presented at the Section meetings.

Perhaps it would not occur to you off-hand, but the Sections also constitute a ready organization which enables the Society to do almost anything it wants to do on occasion or in emergencies such as we had during the war. This Section, like the others, is local headquarters for any active work on which quick action is necessary.

The Sections are organized by action of the Council of the Society, from time to time, whenever there is a reasonable prospect of permanent success by a Section in an automotive center. We have eight at present, and in addition one organized tentatively at Washington.

Some of the Sections have slowed down, from time to time, for industrial reasons, or on account of conditions during the time of war; but on the whole they have been a great success, and there has been no failure of any kind to carry out their functions that could not have been reasonably discounted and expected.

One point in connection with administration is that it has been thought that there should be in all important automotive centers an organization that is very active in fostering the various things which are near the hearts of a body of men such as this. The policy has been that the Sections should have as much autonomy and independence as they want and can use in the proper conduct of their affairs consistently with the keeping of various permanent records, and considering how busy the officers of the Section are with their own immediate business obligations. There is no more striking feature of the work of the Society than the generous and admirable service of the Section officers.

We have been completing some details of the sectional organization which were started prior to the war. There is a Manual for use by the Sections in the various steps of their work. The bookkeeping methods are outlined as simply as possible, to be readily understandable by succeeding governing officers of the Sections.

There is now and always has been a disposition on the part of the Council of the Society to support the Sections morally by all kinds of assistance and financially and in any way that is thoroughly sound and in which the use of the general moneys of the Society can be expended with proper advantage to the membership of the Society as a whole.

The Section activities, you must appreciate, are important and well worth while. The men that you all come in contact with at the meetings are worth associating with. You can learn from them, and they can learn from you, to your mutual advantage. In the Sections, as well as in the Society, we want only a sound membership. There is nothing in the growth of membership, however rapid, unless it be of a probably permanent nature, and every new member that the Society acquires really expects, at the time, to have an enduring connection with the Society and the interests which it is furthering.

Character of Papers Presented

A good amount of attention should be given to the nature of the papers presented at the Section meetings. The social features are valuable in themselves and as helping the other work, but our real function is the dissemination in understandable form of engineering knowledge. The reputation of the Society stands, and must stand, as it always has stood, on the merit of its publications. The Indiana Section, as well as the other Sections, should encourage the presentation of real engineering information, not necessarily of an abstruse nature, in the form of either a comprehensive, clear summary of things that have been known in a general way, or by way of enlightenment on something that is in sight and will probably be reduced to practice soon. Our work is to disseminate reliable engineering knowledge, and anticipate what is to come.

There is a form of affiliation with the Sections, known as Section Associate enrollment.[2] There has been confusion and more or less dissatisfaction about this. The real purpose in providing for the Section Associate, who is not a member of either the Section or the Society, is to permit self-respecting attendance at Section meetings of men who cannot, temporarily, afford to belong to the Society, or the national body, and in turn the Section.

We are fully justified in saying that the Society of Automotive Engineers has in its membership practically all the leading and representative designers and producers in this country of automobiles, motor trucks, farm tractors, airplanes and other aeronautic apparatus, motor boats, and engineers connected with the production of semi-portable, internal-combustion units such as farm engines. There is also a large membership resident throughout the world. These men are members of the

[1]Secretary and general manager, Society of Automotive Engineers, New York City.

[2]By recent action the Council of the Society has eliminated further enrollment of Section Associates by the Sections.

S. A. E., the Society of Automotive Engineers, formerly the Society of Automobile Engineers, which changed its name in deference to those engineers working in various automotive fields, at the time they joined the Society. You may not all appreciate it, but it was a daring thing for the Society to change its name. It was a broad and in a way a self-effacing action. There have been not only no adverse results but the greatest benefits from the far-sighted step. The decision was clean-cut, most timely and very highly effective. No important word in the English language ever went into general use as quickly as or more justifiably than the word "automotive."

As to the cause and explanation of the success of the Society, its growth was forced, in a way, the same as in the case of the automobile industry itself. But the prime reason for the success of the Society is the remarkable cooperation of its members. I have been asked by men working on the staffs of other engineering societies, how we do certain things. The answer is that committeemen appointed by the Society, being actually interested in some real work to be accomplished, assist us in getting ahead on the various matters.

The Society is growing steadily, as it always has grown. We are growing at the rate of at least 1000 members a year, and the new members are of the desirable kind I have mentioned. It is remarkable what a large number of men there are who should naturally be affiliated in the work of the Society. I shall not indulge in any prognostication as to the size of the Society in the future. President Manly treated that subject very well at the 1919 Summer Meeting.

Standardization and Research Work

As to the standards work, which is perhaps the thing that has distinguished the work of the Society of Automotive Engineers from that of other engineering societies, both here and abroad, we certainly have achieved much in the matter of the simplification of material specifications, mounting dimensions and so forth. If the directly traceable benefits of this in money value to the industry be taken as only a small fraction of 1 per cent of the output value of the automobile industry, which is only one of the automotives, it is seen clearly that they represent a very large amount of monetary saving.

The Society has taken the laboring oar in the matter of the solution of the fuel problem, so far as automotive work is concerned. We have held various meetings. The National Automobile Chamber of Commerce has appointed a committee, of which John N. Willys is chairman and other prominent men are members. The American Petroleum Institute has appointed a committee of five to confer with this committee. We have organized also the Automotive Fuel Committee, which is about 100 per cent representative of the associations interested in automotive matters professionally and industrially and of the Government Bureaus.

Some very important work has been going on with respect to securing further screw-thread standardization. The National Screw Thread Commission, made up of government representatives and engineers nominated by this Society and the American Society of Mechanical Engineers, has formulated a very comprehensive and valuable report on this subject. The Commission has visited England and talked the various matters over with the Britishers; and also visited France. There is some prospect of international screw-thread standardization, a thing we would not have dreamed possible a short time ago. There is nothing more important in factories than good screw-thread specification and the setting of limits as they should be. Up to a certain point the closer the limits the more economical the manufacture. Intelligent specification and the absolute maintenance of limits are essential. There have been very few men who have claimed to be screw-thread experts, in this country, or abroad. The average practising engineer depends on these specialists, and knows too little about the merits of the question. There are some very important points involved. Right practice can make or break a factory.

There probably will be some development of international aircraft standards. There is an international commission, the organization of which has not been completed, and something should be done in the way of specifying materials and dimensions of parts that can not only be the same but should be the same in various countries. There are in addition broad questions as to factors of safety and so on.

Generally speaking, there has never been a time in engineering society work as important as the present time. We have never had such consideration of the foundations of science, the arts, and sociology and business, as now. This applies peculiarly to the automotive industry. It is more advanced, more successful, relatively speaking, than other industries, more rapidly developed and developing, and clear acting. No man of real intelligence, I believe, is really cock-sure today as to what is going to happen in the general situation. As to the Society in this connection, it is alongside of the other and older engineering societies. It has been established nationally and internationally and industrially and in a Governmental way. It is very clear that the effectiveness, the elasticity, and the flexibility of all the engineering societies, are now under a severe test. There is much that they should do, and that they can do, if they proceed in the right way. They must give the best possible service that they can to the industries, and to the Government. There are certain relations in engineering matters between the industry and the Government that must be clearly understood and maintained.

It is the duty and privilege of the Indiana Section to assist in all of the work mentioned, and I am sure that it will be willing to do so. The Society of Automotive Engineers illustrates as well as any other organization the truth of the doctrine that the best way to help one's self is to help others. Optimism is peculiarly a matter of viewpoint. An optimist is a man who judges the present by what has happened before. A pessimist makes up his plan in contemplation of an impossible ideal. There is not much in life except the spirit of the true worker. This is the measure of all that has ever been done, or is being done, as well as the measure of what is before us. It is what protects us against political chaos and social insanity. Let us work in that spirit on the matters engaging our attention immediately.

ACTIVITIES OF THE SECTIONS

THE meetings which have been held by the various Sections of the Society during the winter have shown not only an enduring and widespread interest on the part of the members but an increasing popularity as noted by the size of the attendance. A number of the papers presented at the Section sessions will appear in early issues of THE JOURNAL.

Buffalo Section: A meeting of the Section was held Nov. 25, at the Ellicott Club, Buffalo. Lieut.-Col. C. M. Titchenor gave an account of the organization and training of the four regiments of aviation mechanics of which he had charge. He spoke of the difficulty encountered in securing all-around mechanics and expressed the opinion that American industry in striving for quantity production had so specialized the work as to make it extremely hard to find the former type of versatile shopman.

A paper on Japanning Practice by W. A. Darrah, vice-president of the Continental Industrial Engineers, was read at the meeting on Jan. 27. In the absence of the author the paper was read by E. T. Larkin of the Buffalo Section. Due to the general interest in japanning on the part of all members, Mr. Darrah's comprehensive study, which is printed elsewhere in this issue of THE JOURNAL, was received as a valuable addition to the fund of knowledge on the subject.

On Feb. 17 J. Edward Schipper talked on the Current Development of Automotive Industries. He spoke not only of the trend of engineering development but of the pent-up demand for cars due to the reduction of output during the war, and was optimistic as to the future of those companies which are making cars of good quality.

Cleveland Section: A joint meeting of the Cleveland and the Detroit Sections was held Dec. 1 and 2 at Akron, Ohio, where the members were entertained as the guests of the Goodyear Tire & Rubber Co. The morning of the first day was taken up with demonstrations of a six-wheel experimental truck equipped with giant pneumatic tires, and an exhibition of high-pressure air-pumps and various types of wheel designed for use in connection with large-size pneumatic tires. The afternoon was spent in a trip through the Goodyear factory where the visitors were conducted in small groups by technical men of the company who explained points of interest. A banquet was held in the evening at which addresses were made by P. W. Litchfield and F. A. Seiberling. On Dec. 2 several papers were presented. A balloon ascension was made in the afternoon. Four S. A. E. members chosen by lot made an aerial trip of more than 50 miles and reported a thrilling experience. The meeting was an unqualified success from both technical and social standpoints, and those in attendance were unanimous in high appreciation of the many courtesies shown them by the Goodyear company.

Pennsylvania Section: A well-attended dinner and meeting was held Dec. 17 at the Engineers' Club, Philadelphia, where the members listened to an interesting account by A. K. Brumbaugh, chairman of the Section, of his experiences in a transcontinental truck trip. Although no mechanical troubles were experienced, a considerable proportion of the roads was of sand, mud or lava. As both solid and pneumatic tires were used at different stages of the journey, an interesting comparison was obtained of the relative values of both types on various kinds of road.

A joint meeting of the Metropolitan and Pennsylvania Sections was held Jan. 22, at Philadelphia. About fifty Metropolitan Section members were met by the Pennsylvania Section on their arrival in Philadelphia and were entertained at luncheon at the Engineers' Club. After this the Navy Yard was visited and a test of the Diesel engine which had been removed from the former German submarine U-117 was witnessed. Some members of the party then visited the Naval Aircraft Factory, while others were conducted through the submarine U-117.

A dinner was held at Kugler's restaurant and was followed by a paper on Diesel Engines by Hubert C. Verhey, head of the Diesel engine unit of the Emergency Fleet Corporation. Mr. Verhey's paper was well illustrated with diagrams showing the relative efficiency of Diesel and steam installations and the theory on which the Diesel type of engine operates, as well as with photographs and sketches of typical marine Diesel-engine equipment as used in motorships. The meeting was one of the most largely attended and popular gatherings of the season, and the discussion of Mr. Verhey's paper showed the great interest the members have in the subject he treated.

Members of the Pennsylvania Section were guests of the Braeburn Steel Division of Standard Steel & Bearings, Inc., at Braeburn and Pittsburgh on Saturday, Feb. 28. In the morning an interesting trip was made to the Braeburn steel mill, enabling the visitors to witness the various processes of high-grade steel manufacture as practised at this mill. A buffet luncheon followed. In the afternoon entertainment was provided at the Pittsburgh Chamber of Commerce by the exhibition of a seven-reel moving picture showing the complete history of the manufacture of an airplane from the gathering of the lumber to the flying of the plane, together with various evolutions made by it. This picture was taken at the plant of the Dayton-Wright Aircraft Co., Dayton, Ohio, its title being The Yanks Are Coming, and this was understood to be the first release of the picture. In the evening dinner was served at the William Penn Hotel from 6:30 to 8 and this was followed by a theater party at the Davis Theater, thus completing an occasion declared by the S. A. E. members as one of the most instructive and enjoyable that they had attended.

Detroit Section: Commander S. P. Fullinwider, U. S. N., presented a paper on the North Sea Mine Barrage before the Section at the Hotel Ponchartrain, Detroit, on Dec. 19. Commander Fullinwider was chief of the mine section of the Bureau of Ordnance and as such was in charge of the design and procurement of anti-submarine material. His subject was of especial interest to the Detroit Section in view of the fact that a large number of the components entering into the composition of the submarine mines were manufactured at Detroit, the mines being assembled in Scotland to insure secrecy. Although a field some 240 miles long from Scotland to Norway was densely mined, the entire program was accomplished without a single casualty.

At the meeting held on Feb. 27 at the Hotel Statler the members of the Detroit Section heard a very interesting discussion on different important phases of Non-Ferrous Alloys. H. C. Bierbaum of the Lumen Bearing Co., Buffalo, and F. K. Bezzenberger and Dr. Zay Jeffries of the Aluminum Manufactures, Inc., Cleveland, were the speakers. Mr. Bierbaum showed a large number of photomicrographs illustrating typical non-ferrous metal structure and the results of improper mechanical procedure, including tooling. The members were deeply interested in Mr. Bierbaum's remarks, which were based on research work. Mr. Bezzenberger gave a comprehensive and illuminating historical account of aluminum production and utilization. Dr. Jeffries presented in a remarkably clear way fundamental data of great value as to the physical properties of various aluminum alloys and the additional structural purposes in the automotive field it is contemplated they shall be put.

Indiana Section: At the meeting on Feb. 20, at the Claypool Hotel, Indianapolis, W. R. Shimer of the Bethlehem Steel Co. presented a paper on the manufacture of steel. His talk was illustrated with slides showing the methods used in producing steel, from the ore to the finished product. Moving picutres were also shown of the whole process of steel making as practised at the plant of the Bethlehem Steel Co. Mr. Shimer's paper was so clearly written, the pictures were so good and were sometimes taken from such unusual and inaccessible viewpoints, that it is probable that those who attended the meeting received a better knowledge of the manufacturing processes than they would have obtained from a personal visit to the plant. The subject was of unusual interest because of its fundamental nature, and the

(*Concluded on page* 197)

Japanning Practice

By W. A. Darrah[1] (*Non-Member*)

Buffalo Section Paper *Illustrated with* Drawings

THE japanning operation is one of the most important from the standpoint of finish and appearance, but it is one of the few operations which the average automobile manufacturer still carries out on a rule-of-thumb basis, trusting to traditions that the result will be satisfactory. Possibly the combination of chemical engineering, heat application and mechanical problems, has caused this condition. With the thought that an analysis of japanning practice as a systematized industrial operation may work to the improvement of the commercial product, the investigation described herein was made.

Nature of Japans

The lack of definite knowledge regarding japanning practice frequently begins with the manufacturer. In spite of the fact that excellent finishes are now available, many manufacturers are following formulas which in some cases are over a generation old. The average commercial japan usually comprises the following ingredients:

(1) Linseed or other oxidizing oil
(2) Gums or pitches
(3) Drier
(4) Color
(5) Solvent

Fundamentally the average japan consists of a drying oil, which forms most of the body and serves as a medium to impart flexibility to the finished coating. Linseed oil is most commonly used for this purpose, although other drying oils may be employed with the proper precaution. Incidentally, the basic cost is controlled by the quantity of linseed oil employed; the durability and protection are also dependent upon the amount and grade of this ingredient. The presence of an excess of linseed oil has a tendency to make the finish less brilliant than normal, but gives a thicker coat and greater durability, the surface is also somewhat softer and loses its polish more readily, although the protection to the metal is good. On the other hand, too little linseed oil is usually compensated for by the addition of more gums or pitches, in which case the tendency of the japan is to be rather hard and brittle; but the finish is very brilliant. Therefore, the cheaper finishes are likely to be more brilliant than the higher-grade products, but the coating is thin and cracks off with comparative ease, and the protection to the metal beneath is imperfect.

In some cases rubber has been substituted for linseed oil in certain japans, particularly those employed for the first or priming coat. At the present market prices very little rubber is used. It appears that rubber acts in substantially the same manner as linseed oil except that it does not give the smooth finish common to oil. The function of the oil or rubber is to act as a flexible binder and supply the protection to the metal surface, while the gums and pitches serve to give hardness and brilliance to the finish.

Most baking enamels are black or very dark colored on account of the great difficulty of applying and baking a light-colored enamel quickly. Even under the most careful handling, the lighter-colored finishes have a decided tendency to turn yellow or brown. Fading is a common occurrence with most colored baking japans, and the final result is generally unsatisfactory. Carbon black is employed with excellent results in the priming coat of many of the black japans. Aside from the relatively small use of black pitches or gums, carbon black is the most-used coloring material.

Driers are frequently added to commercial japans, but this practice is not to be entirely recommended. The nature and amount of drier employed are of fundamental importance, as any substance which may be subsequently attacked by moisture and air must be avoided. The organic driers are probably the least harmful. It should be noted that the conditions under which japans are usually baked are such as to reduce materially the necessity for a drier. The solvent generally employed is either benzine or solvent naphtha. Benzine is preferred, although both materials merely act as a thinning medium and permit the mechanical application of the japan with greater uniformity and with minimum labor. The solvents are, of course, entirely removed in the drying and baking operation, and it appears that they do not combine in any way with the materials of the japan. As a rule, commercial japans carry about 50 per cent by volume of solvent. It is not unusual to add 15 to 30 per cent solvent at the enamelling plant to facilitate handling and application. The exact viscosity of a japan can be controlled absolutely by the amount of solvent, assuming that measurements are made at a constant temperature, and this is a point of vital importance from the standpoint of securing a uniform product. It is impracticable to advise the best viscosity to employ without full knowledge of all the conditions under which the japan will be used, as well as of the grade of product desired.

The matter of purchasing japan is at present surrounded with much mystery. General appearances and characteristics will tell almost nothing about the quality. A trial application and a test of the resulting enameled surface is a successful and reasonable basis for selecting japans, but it should be kept in mind that the means of application and conditions of baking have an extremely important bearing upon the appearance and durability of the product; an excellent japan may give inferior results when not handled in the best manner. It has been my experience that most japan manufacturers are conscientious in their endeavor to supply a good grade of product. Unfortunately, competitive conditions are such that the price which the consumer wishes to pay is determined, and a japan representing the best grade available for that price is submitted. The ingredient which has the most influence in determining the selling price and quality is linseed oil. In many cases the higher quality japans contain more expensive gums, while the cheaper japans may contain even shellac and stearine pitch.

To decide intelligently upon the best grade of japan and the best method of applying and handling the ma-

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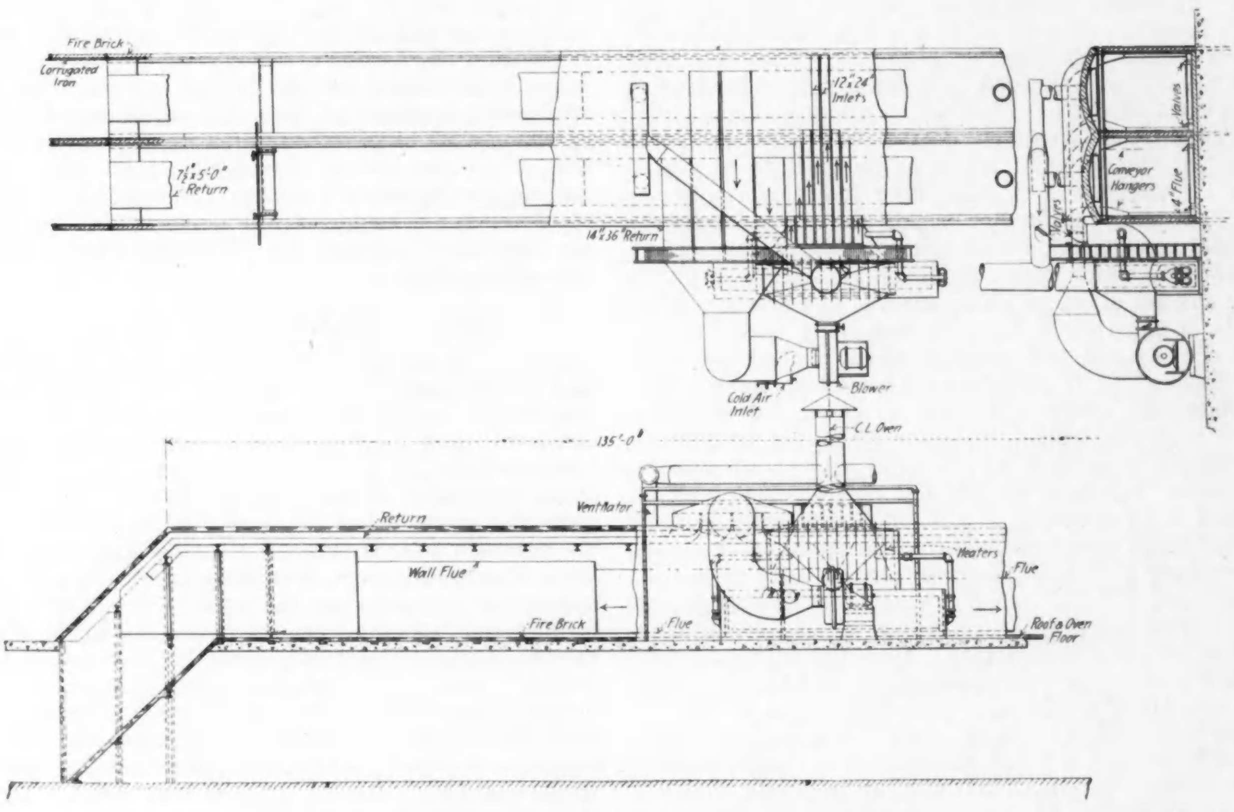
terial a brief consideration of the function of japan is desirable. The original and primary objects of applying a finish to the metal parts were to protect them from excessive deterioration and supply a pleasing appearance to the finished article. To realize these conditions in practice the japan must be weatherproof, somewhat flexible, sufficiently thick to be lasting, have sufficient hardness to prevent excessive scratching under ordinary service conditions and take on a brilliant finish. I will attempt to indicate how these somewhat contradictory requirements can be fulfilled in an ordinary industrial plant without excessive expenditure of money.

Handling Japan

A fundamental requirement of any plant using large quantities of japan is adequate provision for securing a uniform product. As a rule the japan manufacturer is able to supply a uniform product initially, so that the user can confine his attention, aside from the ordinary inspection laboratory tests on purchasing, to the equipment designed to maintain the product constant throughout his own operations. Most systems, whether they be of the dipping, spraying or flowing type, will require large storage capacity for mixed japan, that is, japan plus solvent, and also adequate tankage for mixing the material in use with additional solvent to maintain the viscosity standard. It is very desirable to maintain a uniform temperature throughout the rooms where the japan is handled or mixed. Uniformity is the essential feature, but the best results appear to be secured when the temperatures range from 80 to 100 deg. fahr. Obviously the higher the temperature of the japan the smaller amount of solvent required to secure a given viscosity. On the other hand, if the temperatures of the room and the japan are too high, the solvent has more tendencey to evaporate.

Another consideration of prime importance is to agitate the japan in all parts of the system continually. Even the highest grade product has a decided tendency to deposit some of the heavier ingredients after standing. One engineering means of reducing the trouble from this cause is to avoid the presence of pockets or undrained pools of japan in any part of the piping or tankage system. Entering pipes should end near the top of the tanks and exit pipes should be connected to the lowest portion. All tanks should, of course, be covered wherever feasible, and expose a minimum surface to the atmosphere in case it is impracticable to cover them. Lights and flame should obviously be kept very far distant from all japan equipment. The most satisfactory method of agitating large quanties of japan usually involves a circulating system, including circulating pumps, lawns or strainers, mixing tanks equipped with agitating means and a piping system which should be provided with heat insulation in case the pipes pass through rooms having a lower temperature than that at which the japan is maintained. The mixing and storage tanks should be equipped with some means such as hot-water pipes for maintaining the temperature constant, although this precaution is not always essential if the temperature of the entire room is thermostatically controlled.

Japan is usually applied in one of three ways. Small articles such as automobile fenders can be dipped directly in the tank of flowing japan and after a period of dripping can be carried by conveyors into the baking oven. Large surfaces which cannot be conveniently dipped can be coated by flowing. In this case the japan is pumped through a hose and out of an elongated slotted nozzle, in



General Arrangement of a 135-Ft. Oven for Automobile Bodies

such a manner that it flows smoothly and regularly over a considerable surface. The method of application, when properly handled, results in an excellent finish and is applicable to automobile bodies and similar parts. A third method, also used for applying paints, consists in spraying the coating material by a stream of compressed air. This method, when properly employed, produces good results and also permits some control of the thickness of the coat. The application of japan by spraying is, however, attended by serious personal inconvenience, due to the unpleasant vapors which invariably result; for this reason labor is relatively expensive and difficult to handle. Some attempts have been made to produce an automatic spray or mist so arranged that the article to be treated passes through a closed chamber on a conveyor and under these conditions is entirely coated with paint or japan. Control of the speed of travel of the part to be coated offers a rough means of controlling the thickness of the coat. The spraying method is probably more frequently employed in connection with the painting of chassis and similar parts which do not require a high grade of finish.

The amount of japan which adheres to a freshly coated surface is naturally a variable, depending upon the viscosity of the japan, the condition of the surface and some other factors. It is therefore impossible to make a general statement which will cover all cases, but some instances resulting from actual experience may be helpful. For example, in enameling such materials as front guards, mud aprons, runabout shields and tanks, actual practice indicated a consumption of 1 lb. of liquid japan to each 50 lb. of sheet metal enameled. The metal in this case was naturally a variable ranging from 12 to 18 gage. In another case, in which japan is applied by flowing to one side of the surface only, an average of about 1 lb. of japan to 180 lb. of metal is employed. Here the average thickness of the entire surface averaged about 14 gage metal. As an average, it would seem that about 25 sq. ft. of surface can be covered by 1 lb. of japan in one coat, although, as already pointed out, this quantity is so closely related to innumerable variables that only an approximate estimate can be made. In case a primer coat is applied to the metal, average practice indicates that about 30 per cent additional weight of japan will be required. In other words, because of the numerous crevices which must be filled, the first or priming coat requires an average of about 1.3 lb. of japan for each 25 sq. ft.

It should be understood that the figure of 1 lb. of japan for each 25 sq. ft. of surface applies to the dried japan, as is also the case with the value given for the first or priming coat. The weight of wet or liquid japan, which adheres to 25 sq. ft. of surface, will approach 3 lb. After dripping, the loss in weight by this operation will average about 1.75 lb., while the remainder of the loss in weight results from the evaporation of the solvents during the drying operation. In case the primer coat is sanded before the application of the finish coat, the weight of dry japan removed is about 0.5 lb. per 25 sq. ft. of surface. As a rule spraying japan weighs about 7 lb. per gal., while the spraying paint used on chassis and similar parts will weigh about 9 lb. per gal. From the data and information given above it is possible to calculate accurately the quantities of japan required for a given production and the data, in connection with the figures given for the circulation required, will permit fairly accurate design of the japan-handling equipment. The speeds allowable for the travel of japan through pipes and conduits should somewhat exceed the safe speeds for the flow of oil.

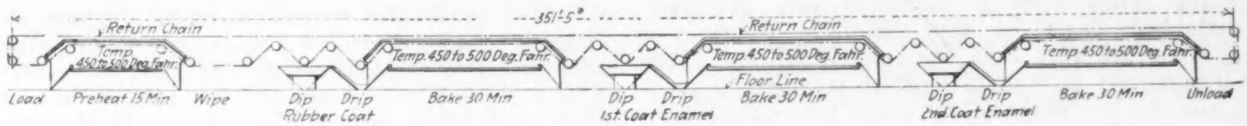
The explosive nature of a mixture of air and the solvent used in japan necessitates a careful study of the air circulation system, wherever japan is employed. As a rule, the danger limits lie between 2.4 and 6.1 per cent of the weight of the solvent in pounds. In other words, a mixture of 100 lb. of air and 3 lb. of evaporated solvent is extremely dangerous. Many disastrous explosions resulted in the early days of japanning due to ignorance of this condition. It is good practice to maintain the maximum concentration of benzine solvent in air at less than 1 per cent by weight, as under these conditions explosions are practically impossible. The basis given of calculating the necessary amount of air circulation is in my opinion much more logical than the empirical method frequently employed of assuming either a given number of changes of air per hour or a given number of cubic feet of air per pound of material japanned. The misleading results which the latter method may involve will be clear when a comparison is made on this basis of the air circulation required for japanning engine flywheels and automobile fenders.

Cleaning the Metal and Baking Japan

It is good practice to thoroughly clean the metal surface before applying the japan coating. While this subject should logically precede the discussion of the application of japan, because of its connection with ovens and heat treatment, it seems better to include it at this point. It is, of course, evident that when the metal surfaces leave the presses and the assembly room, they will be covered with a large amount of grease and other organic impurities resulting from shaping and handling. If this material is not removed the japan will not adhere uniformly, and the appearance will be very unsatisfactory. Two methods are used in practice to remove the oil and grease. One consists in washing the surface with gasoline or other solvent. This is usually quite effective, but as a rule requires more labor and greater care. It is not automatic and depends to some extent upon the care taken by the operator. It also involves very serious fire hazards, by reason of the explosive gasoline vapors evolved in the drying process, and also because of the large exposed tank of gasoline which is necessary. The danger of striking sparks either by friction or from electrostatic causes, as well as the hazards resulting from electric light and power wires, is considerable. I have investigated this subject somewhat, with a view to adding materials which will largely reduce the fire hazard, and have secured some interesting results.

The second method employed consists in burning off the oils and grease in a hot oven. It has been found that a 15-min. exposure to a temperature of about 500 deg. fahr., in the presence of an excess of air, will entirely remove the oily materials without in any way adversely affecting the surface. Naturally, the condition of the surface, the weight of metal to be treated and many other factors will affect this operation. The data given are based upon sheet metal surfaces averaging about 14 gage. In this case the amount of oils and grease removed averages about 0.3 lb. per 25 sq. ft. of surface. The amount of air employed for circulation, under these conditions, can be determined upon substantially the same basis as that employed in japanning practice. In other words, the concentration of vaporized oils should not exceed 1 per cent by weight of the air employed.

Aside from the matter of compounding the japan, no single factor is so important as the baking process. There are many factors which require careful control to secure



General Outline of a Continuous Enameling Oven

a durable, hard, elastic finish, having a good appearance. Some of the more important of these are (*a*) time of baking, (*b*) temperature of baking, (*c*) temperature gradient, (*d*) uniformity of temperature and (*e*) air condition in the oven.

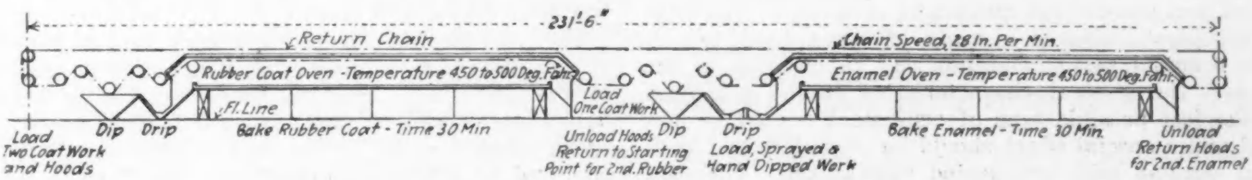
To understand the relations of these factors a brief discussion of the action of the japan during the baking operation will be helpful. After the article to be japanned, such as an automobile fender, has been dipped in japan, the excess of liquid gradually flows from the surface by dripping until a fairly uniform condition has been secured. While in this state the fender enters the japanning oven, being preferably carried by an automatic conveyor, and its temperature is gradually increased. The first effect of the increased temperature is to soften the layer of japan somewhat because the heat has a tendency to lower the viscosity. In case there are any pores in the coating, this action allows them to be filled up. It also results in reducing the thickness of the coat, with the natural consequence that its durability is somewhat reduced. The softening of the surface layer is immediately followed, however, by the evaporation of a portion of the solvent, which in turn tends to harden the japan coating. This action continues throughout the baking period, until the solvent is completely removed. At the same time the linseed oil undergoes a process of polymerization and oxidation, similar to the action in drying paints and varnishes. The presence of a large excess of air is of material assistance in hastening the oxidation process as well as in removing the benzine vapors, and thus hastens the evaporation of the solvent. As the temperature continues to increase, the gums and resins begin to liquify and then to give up certain more volatile constituents in the course of forming a hard condensation product. This is usually the last stage in the hardening of the japan.

It will be evident that the resultant product will have a surface finish depending upon the relative temperature of the japan and the surrounding air. In other words, if the japan and the metal surface upon which it is spread are warmer than the air about it, the polymerization of the oil and the hardening of the gums will take place more or less uniformly throughout the mass, at the same time that the evaporation of the solvent is occurring. Under these conditions the surface will be relatively free from microscopic pits, which are sometimes noticed in poorly handled japan. On the other hand, if the air surrounding the fender is warmer than the metal and japan itself, the surface of the japan will tend to solidify before the interior and even before all of the solvent has been evaporated from the japan layer. One result of this condition is the formation of tiny pores or holes, caused by the evaporating solvent forcing its way through the outer layer or skin. These pores may be microsopic in size but serve as a weak point at which the japan may be attacked by the weather. The pores may also accumulate dust and dirt, thus causing the body of the automobile to have a very unsatisfactory appearance after relatively short service.

It is thus seen that a means of heating the articles to be japanned, which permits keeping them slightly warmer than the surrounding air, is desirable. To obtain such a condition wholly, appears to be impracticable for ordinary commercial work, but it can be approximated by supplying as much heat as possible by radiation from hot bodies. In other words, the heating of a japanning oven exclusively by hot air, is not as satisfactory as heating it by radiating surfaces. The most practical compromise, considering both the quality of the product and the cost of operating the oven, lies in supplying by radiation the heat necessary to raise the temperature of the metal and the japan to the desired point, and at the same time heating the entering air to approximately the temperature of the oven. Generally speaking, the lower the maximum temperature employed in baking the japan, the better will be the resultant surface. It will, of course, be evident that a reduction in oven temperatures means an increase in the baking time, which in turn means either a materially larger investment in oven equipment or a corresponding reduced production.

Japan manufacturers urge the lowest possible baking temperature and the longest possible time, speaking, of course, from the standpoint of securing a durable and generally satisfactory finish. On the other hand, because of the ever-increasing production demands, the tendency of the automobile manufacturers has been to increase the temperature and decrease the baking time. Practice is widely variable in this connection. Excellent results are secured with baking temperatures of from 450 to 475 deg. fahr. In some cases temperatures of from 350 to 400 deg. are employed. A temperature of 450 deg. requires a baking period of about 45 min. to secure the best results, although in some cases baking may be completed in a 30-min. period. Temperatures of from 350 to 400 deg. fahr. require a baking time ranging from 4 to 2 hr. to secure the best results, although this may be materially decreased under some conditions. The possibilities which arise in connection with a quick-setting japan are very attractive, and some surprising results have been secured. I have given consideration to japans in which the solvent is water, and the field here disclosed is very large.

Extensive tests, as well as theoretical considerations,



General Arrangement of a Continuous Enameling Oven for Small Parts

indicate that the resultant surface will be improved if the baking temperature is increased very gradually. The theoretical basis for this condition follows, of course, from the fact that the solvent will be given ample opportunity to evaporate before polymerization of the oil and the hardening of the gums take place. Several large japanning plants have equipment for "preheating" the material before subjecting it to the final baking. Steam coils operated at temperatures ranging from 250 to 300 deg. fahr. are employed for this purpose. In spite of the theoretical advantages and those shown by tests, it is very doubtful whether the preheating principle is of any practical advantage. In the case of at least one manufacturer, equipment already installed for this purpose is not employed. If preheating is not used, the temperature gradient will be substantially a straight line, increasing rapidly to a maximum at the entering end of the oven, in the case of a continuous equipment, and continuing at the maximum temperature throughout the baking period. It is obvious that uniformity of temperature throughout the oven is of the utmost importance. Lack of uniformity is very likely to result in hard, brittle, over-baked portions, or gummy and soft spots, which will collect dirt and dust as well as show excessive scratching.

It is desirable that the air supplied to japanning ovens should be controlled in some positive manner, as natural ventilation should not be relied upon. It has been the experience of those plants relying upon natural ventilation to maintain the air circulation, that extremely variable results are secured. In these cases the ovens require constant supervision and the rate of production must be decreased to compensate for weather changes. The air used for circulation within the japanning oven, must be relatively free from dust, and as dry as possible. In some plants the precaution of washing the incoming air has been taken, but this does not seem to be necessary under ordinary operating conditions. The advantages of preheating the air to oven temperature will be seen when it is considered that this tends to remove a portion of the lint or dust by burning, and also lower the percentage of saturation.

To secure a high-grade finish it is customary to apply at least one primer or "rubber" coat, followed by from three to four finish coats. The primer coat is usually somewhat thicker than the others and carries most of the pigment, carbon black. The treatment, application and baking of the three coats are substantially the same, as regards both time and temperature. The primer coat usually gives a dull or rough finish without hardness or brilliancy; the latter characteristics are supplied by the finish coats.

Japanning Plant Equipment

The japanning plant includes the following essential elements: (*a*) japan storage and handling equipment, (*b*) a mechanical conveyor and (*c*) cleaning and baking equipment. The equipment involved in the storage and handling of the liquid japan has been dealt with briefly in the earlier portion of this paper.

The mechanical conveyor may take many different forms, depending upon the nature of the material to be handled and the desired method of treatment. Each individual plant requires a study of many local factors before a sound recommendation can be made as to the type and the general characteristics of the conveyor. The simplest possible type of equipment should be employed and a special effort should be made to avoid both special designs and complicated mechanism. The fact should be kept constantly in mind that difficulty with the conveyor system will completely tie up the plant until it is corrected, involving not only a loss of production and time, but possibly causing a large amount of defective work. With this in view, the conveyor should be provided with ample factors of safety in all its parts, and present operating practice should be freely considered. The relatively high operating temperatures to which some portions of the conveyor are continuously subjected, should be kept in mind from the standpoints of lubrication, wear and strength. At temperatures in the neighborhood of 450 deg. fahr., most oils are valueless, and babbitt or composition bearings are objectionable. It is also of interest to note that the light from the mercury arc lamp has been found to be peculiarly suited for inspection of japanned surfaces. Experience indicates that the monochromatic nature of light from this source allows ready detection of cracks and imperfections.

The japanning oven is one of the most important parts of the plant equipment, since on the proper operation of this apparatus depend the uniformity and quality of the output. While there are many conflicting requirements incidental to the successful operation of japanning ovens, a few of the fundamental considerations are (*a*) safety, (*b*) reliability, (*c*) controllability, (*d*) economy, (*e*) production and (*f*) cleanliness.

Two fundamentally different mechanical arrangements are employed in the construction of japanning ovens, although both types consist merely of a large box, usually of metal, surrounded by from 3 to 6-in. of heat insulation. In the case of the earlier or batch type of oven, the material to be japanned is placed in the oven, the doors are closed and the temperature is raised to the desired point. The heating is continued for the necessary length of time, and usually some means of ventilation is employed. The batch type of oven, when properly operated, will produce excellent results, and is particularly adapted to small plants. Automobile factories producing not more than 100 cars per day can secure excellent results with this type, although it will be evident that continual supervision by skilled and responsible help is necessary. The fuel economy in the case of the batch type of oven is usually much lower than in the case of the continuous oven, and the labor charges are much higher.

The continuous japanning oven differs from the batch type only in that it is a long heat-insulated box, usually open at both ends, and equipped with conveying means for continuously carrying the material to be treated through the oven. In all plants having a production materially in excess of 100 cars per day the continuous oven is preferable. Continuous ovens are constructed in many varying designs, some typical installations being shown in the accompanying drawings. For treating automobile bodies in cases now becoming relatively numerous in which no wooden parts are built into the metal body, it is usual practice to employ an oven about 140 ft. long, 5 ft. wide and 6 ft. high. The ovens are generally entirely horizontal in this case, but are provided with vestibules which serve to reduce the circulation of cold air from without, thus keeping the temperature within the oven higher and more uniform. In the case of body ovens, two parallel horizontal chains are used for conveyors, the chains sliding in steel channels or angles at a level of about 2 ft. from the floor. The bodies to be japanned are placed on the conveyor with about 4 ft. of space between each. In the case of an oven 140 ft. long, operated at a temperature of 450 deg. fahr., a 45-min.

baking period is usually employed, thus allowing a speed of travel for the conveyor of about 3 ft. per min. This rate of travel permits ample time for inspection as the bodies leave the oven, and the application of a second coat of japan before the bodies enter the second oven. Under these conditions, a period of about 10 min. is allowed for inspection and applying the next coat. This, of course, requires a distance of about 30 ft. on the basis of a speed of travel of 3 ft. per min. The above figures are merely given as typical of successful installations now in operation.

The question of ventilation for japanning ovens has already been discussed and it is merely necessary to give some typical figures illustrative of present practice. An oven adapted to the japanning of light automobile bodies, with an hourly production of about 12 bodies, will require an air circulation approximately equal to 1200 cu. ft. of fresh air per min. There are at present a large number of japanning ovens employing natural ventilation to cause the necessary air change. In my opinion this is unfortunate, since the operator cannot control the rate of circulation or the nature of the incoming air.

A second type of japanning oven represents present practice in the treatment of automobile fenders and similar light parts. It will be noted in this case that the entire process of dipping, dripping, baking, etc., is carried out automatically, and that manual labor is required only in placing the pieces to be treated on the conveyor, inspecting them and removing them when completed. There are two typical methods of reducing the leakage of hot air from the oven and the consequent entrance of cold air. Both methods depend upon the lower specific gravity of warm air causing it to rise. In the one case the oven is located on the roof, while the material to be japanned enters at one of the lower floors, passing up an incline before it reaches the hottest portion of the oven. Another method of securing substantially the same result, but modified to deliver the finished product nearer to the point at which it enters, is exemplified in the case of a double-deck fender oven now on the market.

Heating Methods

There are in use today at least three different means of supplying heat to japanning ovens. The oldest and least satisfactory arrangement consists in having a number of gas burners placed beneath the floor level of the oven and arranged so that the gaseous products of combustion will pass upward and impart a portion of their heat to the materials to be japanned. The objections to such a system are obvious. The temperatures are not subject to accurate control, the temperature of the ovens is not uniform throughout, the dangers of fire from an open flame are excessive and the products of combustion passing through the oven frequently contain traces of soot and always large amounts of water vapor. As a result of these conditions the quality of the work produced by an oven of this type is not as satisfactory as that of later types, and with the present price of gas the operating costs are high.

The electrically-heated oven has been widely introduced and is in successful use at a large number of plants. Electric heat allows simple and accurate control, permits a relatively uniform temperature throughout the oven and is free from the objections of soot and water vapor inherent in the gas-fired oven. The most serious objection to the electrically-heated oven is the extremely high cost of this form of heat. A consideration of the fact that even large power users cannot as a rule secure a lower rate for japanning equipment than from 1 to 1½ cents per kw.-hr., will make evident the very high costs involved. For example, one large automobile builder producing approximately 1000 cars per day, has a power bill for the japanning ovens alone of about $1,500 per day. For purposes of comparison, it may be stated that the same service secured from japanning ovens heated by the combustion of fuel oil would cost not over $400 per day, giving a yearly saving of over $300,000. It should be noted that while the electrically-heated oven can be most easily controlled and is normally very reliable, yet in this case the manufacturer is dependent upon power service. In case of any interruption of the central station service his ovens are closed, thus stopping all production and possibly causing a material loss of product.

The third and more modern system of applying heat to japanning ovens consists of the so-called air-heated type, in which the ventilating air and radiant heating means are both maintained at the desired temperature by the combustion of oil or gas in a small separate oven composed of refractory materials that serves as a firebox or combustion chamber in which the fuel is burned. Mounted above this are a series of air heaters which are divided into three groups. The first and smallest group is employed to supply preheated air for the combustion of the fuel in the heating oven. The second and largest group is used to heat a volume of circulating air which passes through flues arranged longitudinally along the sides of the oven and out, returning through a blower to the heaters. This volume of air serves to transfer the heat which is produced at high temperatures in the combustion oven, to the material to be japanned, where the temperatures are relatively much lower. One large installation of this kind, which may be considered typical, has been designed on the basis of 650 deg. fahr. for the temperature of the air entering the radiating flues and 450 deg. fahr. for the air when leaving the radiating flues. The third set of heaters employed in this system are used to preheat the air used for ventilating purposes, thereby overcoming one of the serious difficulties experienced with the earlier type of electrically-heated oven, namely, the lack of uniform temperature throughout the different portions of the oven.

It will be noted that this latter air-heated type of japanning oven permits of securing all of the advantages of the other types, with the additional advantages of economy, reliability and controllability. It will be apparent that by the use of large radiating flues which cover substantially the entire sidewalls of the oven, and are maintained at temperatures about 200 deg. higher than that of the oven, a large amount of radiant heat is applied to the material to be japanned, with the resultant advantages which have been outlined. On the other hand, the preheating of the circulating air insures that a large amount of warm entering air will be at all times passing through all portions of the oven, thus eliminating the "cold pockets" which are a troublesome feature of the electrically-heated oven. This forced circulation of warm gases also prevents the accumulation of the relatively heavy volatile products formed in the drying of the japan. The fact that the pressure within the japanning oven, by this system, is somewhat greater than the external atmospheric pressure, although only a small fraction of an ounce, overcomes the difficulty which is sometimes acute in the electrically-heated oven resulting from the flowing in of cold air in the horizontal type of oven, owing to the draft induced by the exit of the circulating air.

On the present basis of fuel oil, at approximately 4

cents per gal., it has been found that an oil consumption of not over 50 gal. per hr. will entirely supply heat to a continuous body japanning oven 140 ft. long and having an hourly output of at least 12 automobile bodies. This results in an actual fuel saving equal to nearly two-thirds of the cost. In the case of the air-heated oven described above it will be noted that none of the products of combustion enter the oven, and therefore the difficulties inherent in the earlier types of gas-heated ovens are avoided. Obviously no soot or water vapor is carried into the oven from the heating chamber.

Temperature Control and Mechanical Construction

To produce work of a high quality continuously, the absolute control of the temperature throughout the japanning oven is essential. From the foregoing discussion on the properties and characteristics of japan, it will be evident that if the time in which the bodies are submitted to the baking temperature is kept constant, the temperature also must be maintained constant or the japan will be either under-dried or over-baked. Commercial practice has finally reduced successful temperature control to the basis of a pyrometer operated either by a thermocouple or a variable resistance. In either case, the change in an electric current caused by the change in the oven temperature operates a meter which is connected to a relay. The relay is used to close a power circuit controlling an electrically-operated switch, in the case of an electrically-heated oven, or an electrically-operated oil-and-air valve, in the case of the air-heated oven. The quickness of response to slight temperature variations is substantially the same in both cases.

In the case of an oven 75 to 150 ft. long, it is usually good practice to divide the temperature control of the oven into two or more sections, each of which may be controlled individually. It is not uncommon in the case of an oven 135 ft. long to place four thermocouples in the roof along the center line of the oven at approximately equal intervals. In this case, the four sections of the oven would be controlled individually and automatically. It is also common practice to provide manual control in addition to the automatic control, in order that the temperature of the oven as a whole can be varied when necessary. The necessity for such variation has resulted quite largely from the use of natural draft, and the consequent variation of oven performance with weather conditions. The necessity for such temperature variation is materially less in the case of those ovens in which the ventilating air is preheated and supplied under slight pressure, so that oven conditions and air circulation are independent of weather variations.

It has been previously pointed out that essentially the japanning oven consists of an insulated box provided with heating means and conveyor equipment. There are naturally many different mechanical constructions in use, many of which give satisfactory results. From the standpoint of heat insulation it is good practice to have the walls at least 4½ in. thick, and in case electric power is used for heating, a materially greater thickness is warranted because of the decided economy obtained in operation. It is desirable, in designing the oven, to have a minimum of exposed radiating surface per unit volume of useful oven space. In other words, when possible, two or more ovens should be grouped together, thus reducing radiating losses. In connection with the location of ovens, it may be pertinent to suggest that in many cases they can be placed on the roof, thus economizing floor space.

In constructing a japanning oven it is essential that the walls be air-tight in order that there may be no leakage of gases either into or out of the oven, other than as provided by the ventilating equipment. The oven structure should be as light as possible consistent with mechanical strength. Consideration must be given in the design to the fact that in a length of 100 to 150 ft. the total expansion resulting from a temperature change of about 400 deg. fahr. may be several inches. Particularly in case ventilating and heating flues are introduced and designed to operate at higher temperatures than the remainder of the oven, the factor of thermal expansion must be considered. Much stress has been laid upon the desirability of avoiding all so-called "through metal" in oven construction. Undoubtedly all metal which extends from the inside of the oven to the exterior serves as a source of loss by heat conduction, but it is my opinion that in many cases this factor has been unduly emphasized for trade reasons, and possibly with a sacrifice of other advantages.

STANDARDS COMMITTEE DIVISION MEETINGS

A TENTATIVE schedule is given below of Standards Committee Division meetings to be held prior to the meeting of the Society in June. The schedule is subject to modification as conditions may require. Formal notice of the final date and place of the meetings will be sent in due course to all members of the several divisions.

Division	Date	Place
Aeronautic	May 12	New York City
Automobile Lighting	May 3	New York City
Ball and Roller Bearings	May 7	New York City
Electrical Equipment	May 4	Detroit
Electric Transportation	April 5	New York City
	May 11	New York City
Engine	May 11	Cleveland
Iron and Steel	May 10	New York City
Isolated Electric Lighting Plant	April 29	Chicago
Marine	May 5	New York City
Miscellaneous	May 6	Detroit
Motorcycle	April 28	Chicago
Non-Ferrous Metals	May 10	Cleveland
Roller Chain	May 14	New York City
Springs	May 5	Detroit
Stationary Engine	May 3	Chicago
Tire and Rim	May 14	Cleveland
Tractor	May 1	Chicago
Transmission	May 7	Detroit
Truck	May 15	Cleveland
Subdivision on Wheels	April 1	Cleveland
	May 13	Cleveland

COST OF AIR MAIL SERVICE

SECOND Assistant Postmaster General Otto Praeger has reported that the air mail service is not costing the public one cent but is saving more than $100,000 annually. It costs much less than $400,000 a year to operate an airplane capable of carrying 1500 lb. of mail on a schedule calling for one round-trip daily between New York and Chicago. The establishment of such a schedule has enabled the Post Office Department to dispense with railroad distributing space and clerical help costing approximately $500,000.

Aeronautic Meeting of the Society

DURING the week of the Aeronautical Show conducted by the Manufacturers' Aircraft Association at New York City this month, there were several interesting and valuable Society events in the furtherance of the progress in aircraft by the presentation of up-to-date papers on engineering subjects, sessions on standardization work and after-dinner addresses.

Vice-president Glenn L. Martin presided at the professional session held on the afternoon of March 10. Major V. E. Clark outlined a paper he had prepared on Possible Airplane Performance with Maintenance of Engine Power at All Altitudes. He also showed some moving picture films of recent engineering work at McCook Field, the particular items of interest referring to devices for dropping the wheels from a plane when in the air and for inflating air bags for the purpose of absorbing a portion of the shock when landing on water; examples of dropping bombs separately and in unison, and parachute work. Interesting points were elucidated concerning the recent ascent of Major Schroeder to 36,000 ft. in a LePere plane driven by a Liberty engine equipped with a Moss supercharger. It was stated that on account of rarification of the atmosphere at such great altitudes the carbon monoxide in the engine exhaust becomes so diffused as to be harmful and dangerous to the pilot and that under such conditions arrangements will have to be made to carry the exhaust gases well away from the pilot. The reported temperature was —67 deg. fahr., one result of this being the formation of the exhaust into a comet-like icicle of astounding length.

As was stated by Vice-president Martin, the papers presented showed that marked progress has been made recently in aeronautic engineering. Grover C. Loening, in a paper entitled Effect of the General Shape of Aviation Engines on the Operation of Airplanes, gave some very interesting data on the power developed by and the air resistance involved in the use of aeronautic engines currently made. His purpose was to analyze the conditions requisite for an airplane speed of 200 m.p.h.

Alexander Klemin gave an enlightening exposition of his subject, Consideration of Landing Run and Getaway by Standard Type Airplanes. Archibald Black presented a brief statement on matters demanding attention in the heat-treating of brazed fittings. S. R. Parsons and S. W. Sparrow, of the Bureau of Standards addressed the members, the former on Factors in the Design of Airplane Radiators, and the latter on Flying an Aviation Engine on the Ground. Mr. Parsons' data were constituted of some results of tests that had been conducted at Washington. Mr. Sparrow told of the many advantages of testing engines in a laboratory such as that installed at the Bureau of Standards, wherein conditions of atmosphere and temperature like those at great altitude can be maintained.

Chairman Henry M. Crane of the Aeronautic Division of the Standards Committee, gave a dinner to the members of the Division at the University Club on March 9, after which the program of further standardization work in the aeronautic field was discussed and formulated. On the following morning a formal meeting of the Aeronautic Division was held at the offices of the Society and a subsidiary committee organization was decided upon for the purpose of collecting and analyzing data prior to the next meeting of the Division which will be held in May. The Army and the Navy were represented at the sessions held here this month.

The Dinner

At the Aeronautic Dinner held at the Hoter Astor on the evening of March 10, President Vincent urged as a basic function of the Society's activities the reduction of cost to the producer and to the consumer and making feasible at the same time better products. He emphasized the fact that thorough preparedness in the air will depend upon commercial aviation development, it being assumed that it will take some time to place aviation on a commercial basis. As it is necessary to depend upon the Government largely, it is essential that the members of the Society should cooperate with the Government representatives with the view of obtaining for every dollar spent on aviation by the Government the greatest possible value as measured in terms of preparedness. Mr. Vincent discussed the possibilities of our aerial mail from the engineering and production standpoints. He stated that our aerial mail service had been very well handled and that considering the appropriations available desirable results had been obtained. He advised that this service be developed in a whole-hearted manner, explaining the various advantages to be derived from such a procedure. He thought that if the program he outlined were followed out the United States would lead the world in aeronautics inside of a very few years.

Major-General C. T. Menoher, chief of the Air Service, presented some facts as to the present status of military aeronautics. He stated that in the event of aircraft economic failure the tremendous expense involved in maintaining an air fleet will limit unduly the number of planes which can be maintained in preparation for war. He cited as a significant fact that at the price of about $35,000 per plane a fleet of 1000 bombardment planes can be acquired for the present price of one battleship. General Menoher reported that the Air Service has a definite program as to the number and the types of planes needed, the only thing lacking being Congressional authorization and appropriation.

In connection with the controversy as to the establishment of a separate or a united Air Service, General Menoher said that in his opinion the Army should retain its own Air Service as a part of the Army, including personnel and materiel necessary to carry on the work of a thoroughly balanced force complete in all its parts. He argued that the Army, as well as the Navy, having special requirements in aircraft not appreciated by any purely civilian agency, should carry forward its own experimental development; and that after types suitable for the special needs shall have been determined, production should be conducted by some other organization.

Commander G. C. Westervelt, manager of the Naval Aircraft Factory, supported General Menoher in a forceful way as to the advisability and necessity of the Army and the Navy maintaining aeronautic activities independently.

In talking on the development in America of commercial air flight, Past Vice-president George H. Houston of the Society remarked that two distinct sides are to be considered in the separate air service discussion, some points involved including those of administration not being covered satisfactorily in the policy advocated by General Menoher and Commander Westervelt. Mr. Houston stated that while it is undesirable for the Government to undertake to design its own aircraft, instead of furthering the development of such design through civilian competitive initiative, it is desirable that the Government conduct fundamental experimental work, and that to this end there must be maintained by it an organization properly equipped for the testing out of new designs and carrying on such work as is necessary to establish soundly the science of aerodynamics.

Major Maurice Connolly told the members what he believed could be accomplished by aircraft sales departments, stressing the fact that in the work of facilitating the establishing of the necessary landing fields, concrete propositions as to business that can be done thereon should be made.

Col. Thurman H. Bane, chief of the Engineering Division, Air Service, McCook Field, made some very spirited and optimistic remarks as to the large scale use of aircraft that should be anticipated. He presented the view that the maintenance and operation of aircraft for all the various arms of the Government service might well be subordinated in a National Defense Department.

Brigadier-General L. E. O. Charlton, formerly military attache of the British Air Service, in response to a call from Toastmaster Glenn L. Martin, reiterated the importance of fostering aircraft governmentally.

REFINED OILS 1919 STATUS SUMMARIZED

THE 430,465,567 bbl. of crude petroleum that was produced and imported in the year 1919 is accounted for as follows: 5,925,586 bbl. was exported, 328,879 bbl. was shipped to our insular possessions and the refineries accounted for 361,520,153 bbl., making a total of 367,774,618 bbl. of oil. This leaves a balance of 62,690,949 bbl. that was consumed in the natural state. Of the 52,746,567 bbl. of petroleum that was imported during the year, 30,828,264 bbl. of Mexican crude was run by the refineries, which in addition used 1,446,326 bbl. of Mexican tops.

Gasoline production increased 10 per cent over that of 1918, October being the high month in production and January the low month. Stocks indicate the seasonal demand for this product; the largest stocks were on hand at the refineries at the end of May and the smallest stocks at the close of January and October. Stocks in the year increased from 297,326,983 gal. to 446,793,431 gal. Exports decreased about 190,000,000 gal. in the year, while the domestic consumption increased 309,000,000 gal.

Kerosene has consistently increased in production since August, 1918, and the 1919 increase amounts to 28 per cent over the production for 1918, the largest monthly production occurring in the month of December, 1919, the low month being January of that year. Stocks of this oil have declined from a high point in October, 1917, to the lowest stock in May, 1919; since this time there has been an increase to the highest point of the past year in November. Four hundred and eighty million gallons more kerosene was exported during 1919 than in 1918, and 8,000,000 gal. was shipped to our insular possessions in excess of the shipments in 1918, but domestic consumption decreased by 50,000,000 gal.

Gas and fuel oil has increased in production in the year by 4 per cent; March has the smallest monthly production, while August and December are credited with the largest productions. Stocks of this product increased steadily from a low reserve at the refineries at the end of January, 1919, to a large stock in September; since that date, stocks have declined rapidly. Exports of gas and fuel oils decreased 303,000,000 gal., but shipments to our insular possessions increased by 63,000,000; and 571,000,000 gal. is the increase for domestic consumption. The use of bunker oil for vessels engaged in foreign trade, for 1919, increased 114 per cent over the year of 1918.

Lubricating oils for the year have maintained a steady production throughout the year. Stocks were the largest in June; the end of December shows the lowest stock of the year.

COMPARATIVE ANALYSIS OF OIL PRODUCTION AND CONSUMPTION

Income	Gasoline		Kerosene		Gas and Fuel Oils		Lubricating Oils	
	1919	1918	1919	1918	1919	1918	1919	1918
Stocks Jan. 1, gal	297,326,983	412,256,833	380,117,829	497,750,082	659,001,357	577,899,112	138,853,574	136,856,348
Production, gal.	3,957,857,097	3,570,312,963	2,341,632,164	1,825,360,137	7,627,288,566	7,321,397,557	846,760,017	841,465,767
Total, gal	4,255,184,080	3,982,569,796	2,721,749,993	2,323,110,219	8,286,289,923	7,899,296,669	985,613,591	978,322,115
[1]Exports, gal	365,883,011	556,422,334	965,415,225	484,613,905	1,174,166,557	1,477,085,287	276,051,479	256,300,689
Shipments to our insular possessions, gal.	16,217,081	12,209,957	20,272,439	11,830,802	107,630,830	43,986,549	3,860,199	2,615,666
Domestic consumption, gal	3,426,290,557	3,116,610,522	1,396,742,639	1,446,547,683	6,290,368,081	5,719,223,470	568,382,979	580,552,186
Stocks Dec. 31, gal.	446,793,431	297,326,983	339,319,690	380,117,829	714,124,455	659,001,357	137,318,934	138,853,574
Total, gal	4,255,184,080	3,982,569,796	2,721,749,993	2,323,110,219	8,286,289,923	7,899,296,669	985,613,591	978,322,115

[1]Figures on exports and shipments are taken from reports of the Bureau of Foreign and Domestic Commerce. The exports of gas and fuel oils includes fuel or bunker oil for vessels engaged in foreign trade. For the year 1919, 14,031,356 bbl.; for 1918, 6,578,141 bbl.

Design of Intake Manifolds for Present Heavy Fuels

By F. C. Mock[1] (*Member*)

Mid-West Section Paper *Illustrated with* Drawings and Chart

In the early days of the motor car, the adoption of our system of feeding a number of cylinders in succession through a common intake manifold was based upon the idea that the fuel mixture would consist of air impregnated or carbureted with hydrocarbon vapor. If the original designers of internal-combustion engines had supposed that the fuel would not be vaporized, but instead exist as a more or less fine spray in suspension in the incoming air, it is doubtful whether they would have had the courage to construct an engine with this type of fuel intake, for it would have required very little imagination to foresee some of the difficulties which we have grown to tolerate in recent years because they have come upon us so gradually.

That our present fuel does not readily change to hydrocarbon vapor in the intake manifolds is indicated by tables of vapor density of the different paraffine series of hydrocarbon compounds, which show that even with elements of 58 deg. Baumé gravity and a boiling point of about 340 deg. fahr., the vapor density necessary for combustion can be obtained only with a vapor temperature above 110 deg. fahr. This means that for certain vaporization of fuels containing elements of this density, the intake manifold must be heated to a temperature a little greater than the hand can bear continuously; and our present gasoline contains a large percentage of ingredients much less volatile than this. I think it is the experience of everyone who has observed these conditions closely that we have almost no difficulty with "carburetion" when adequate mixture temperatures are obtained, and practically all the troubles in this line occur when the manifold temperature is lower than this point.

To verify our belief that the fuel cannot evaporate in the intake manifold at ordinary temperatures, we built a large tank with a conical bottom of sufficient size to hold about 2 lb. of air. We have repeatedly put into this 2/15 lb. of different samples of gasoline and allowed it from ½ hr. to 3 weeks to evaporate, blowing a draft of air upon the surface of the fuel in the bottom of the tank to facilitate its evaporation. With gasoline of 56-deg. Baumé gravity from Oklahoma crude, we were able to draw off about 60 per cent of the amount we had poured in; with 60-deg. Baumé gasoline from California petroleum we drew off about 30 per cent, both these experiments being conducted while the temperature of the tank was between 68 and 75 deg. fahr. Repetition of the experiment with different durations of time seemed to indicate that the vapor reached equilibrium in a very few minutes.

A final definite proof that the fuel does not evaporate in the manifold is obtained when you build windows or glass sections in the manifold and look at it. With the airplane gasoline used in the recent war, of about 68-deg. gravity and an end point of 257 deg. fahr., the mixture in the manifold was quite wet at 60 deg. fahr. and became completely dry, with wide-open throttle, at a temperature between 100 and 110 deg. fahr. With our mid-west gasoline of about 56-deg. gravity and an end point above 400 deg. the mixture is wet at and below 120 deg. fahr. at all throttle positions except extreme idle. When the throttle is closed it reduces the air density in the manifold, and if the mixture proportion of the carbureter is properly maintained less fuel will also be fed, so that a lesser vapor density will be required at partial throttle openings. For this reason the mixture will always be more nearly evaporated at closed than at wide-open throttle.

Certain benzol-mixture fuels now sold at Chicago are remarkable in that the manifold is dry and the mixture absolutely transparent at wide-open throttle at 80 or 90 deg. fahr.

Critical Air Velocity

When the fuel issues from the carbureter nozzle and sprays out into the air-stream, we believe that the condition of vapor saturation is reached very shortly after it leaves the nozzle, and all the fuel which can evaporate at that temperature does so. The remainder continues in the form of small drops which may either be carried along in suspension in the air-stream or, if the air draft is too weak, fall back and collect on the walls and the bottom of the air passage. Thus we have a critical air velocity below and above which the action in the manifold and the fuel feed to the engine are radically different. When the air velocity is sufficient to carry the fuel drops along with it, the temperature in the manifold is not so important and the ability to handle the fuel depends more upon the temperature in the cylinders. For instance, I have known of engines that will fire on kerosene almost as well with a cold small intake manifold of high air velocity as with a heated manifold, provided in both cases the cylinders are sufficiently hot. Also at high velocities the distribution of fuel to the different cylinders tends to follow the distribution of air fairly closely and is less dependent upon the contour of the manifold bends and curves.

Below this critical air velocity the fuel after leaving the carbureter nozzle slows down, because in practically all carbureters the air velocity at the nozzle is higher than that in the manifold. In this slowing down the particles tend to drop out of the mixture and settle upon the walls, and when they strike any obstacle or pass around any bend they adhere to the walls and are not wiped off again by the air draft. This develops an accumulation and irregular flow of fuel along the walls, with the result that not only is the rate of fuel feed different to different cylinders, but it is often different *into the same cylinder on successive suction strokes.* Another particularly objectionable thing is the time lag between an increase of fuel flow at the carbureter and an increase of fuel flow at the cylinder. When the throttle is opened quickly

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from a closed position the increased air feed reaches the next cylinder on the suction stroke, but the unevaporated part of the increased gasoline feed does not reach any of the cylinders until several revolutions later. It is this erratic chronological variation of fuel feed to the cylinders that we blame largely for many of our difficulties in operation, such as gasoline getting past the pistons into the crankcase, an accumulation of carbon and fouling of spark-plugs. It is also the reason our present-day engines are very sensitive to every variation in ignition, because it seems that the more erratic the vapor content in the cylinder the more heat units are required in the spark to effect ignition.

Another condition which seems to assist the precipitation of the drops from the mixture is change in the direction of flow. In the multi-cylinder manifold, when the cylinders draw one after another in different directions, at each suction stroke there is a certain reversal of flow along the manifold, and at this time the air will slow down and gain velocity in a reverse direction much more easily than the heavier gasoline drops. We believe it is largely for this reason that the difficulties of distribution increase with the number of cylinders.

I have made a few experiments with glass manifold sections to determine what velocities are necessary to keep a fairly well atomized mixture in suspension. These indicate that under a steady non-pulsating air-flow a velocity of 38 ft. per sec. is necessary to keep the atomized drops off the walls in a vertical pipe. After passing around a bend or tee the requirements are more severe because the fuel has once been thrown on the walls by centrifugal force and must be wiped off again by the air velocity. We seem to find that to keep the intake manifold walls clean beyond a tee or fairly sharp bend requires a manifold velocity of about 75 ft. per sec. Under conditions of pulsating flow, with suction strokes which do not overlap, as with engines of four cylinders or less, we have reason to believe that the critical velocities are somewhat less, say about 80 per cent of the values above given.

To simplify the computation of air velocities we have prepared the curve shown in Fig. 1. The mean manifold velocity for any given engine will depend upon the total displacement of the engine, the revolutions per minute, the volumetric efficiency and upon the diameter of the intake passage. These curves have been made on a basis of 90 per cent volumetric efficiency which is probably in excess of that obtained with any of our engines at their normal operating speeds. Having given the piston displacement of the engine, we multiply it by the desired number of revolutions per minute and use this value as an ordinate, from which the air velocities corresponding to different diameters of intake passages may be easily read off.

Range of Manifold Velocities

Our chief difficulty in manifold design comes because our engines must operate through a large range of speeds. If a car is designed to run at a maximum speed of 50 m.p.h. with a wide-open throttle and the intake manifold is designed for a velocity of 200 ft. per sec. at this speed, a velocity of 75 ft. per sec. will correspond to about 19 m.p.h., below which there will probably be some difficulty in getting proper carburetion with a cold intake charge, and a velocity of 38 ft. per sec. will correspond to 9½ m.p.h., below which it will probably be very difficult indeed to get the engine to fire properly with a cold manifold and a moderately lean mixture. It is, of course, possible to change the mixture vapor content, with a fuel containing a number of different elements, by increasing the rate of fuel feed, and thus increase the vaporization from the light elements fed.

I have heard of cars which were designed to operate with a cold manifold at 1 m.p.h. with a wide-open throttle. On this basis, with the above manifold, the air velocity would be but 4 ft. per sec., or 2⅔ m.p.h. An intake manifold with a velocity as low as this looks very bad. As you all know, a 2⅔-m.p.h. breeze can scarcely be felt; and I am quite sure the manifold walls would be covered with tears of grief because the gasoline could not get up to the cylinders.

It is possible to overcome these difficulties to a large extent and get a much wider operating range with a passenger-car engine by the proper application of heat. I simply wish to emphasize the futility of trying to design a high-speed passenger-car engine without giving careful attention to this application of heat. We can give an engine large valves, lighter reciprocating parts and efficient lubrication, but if we design the intake manifold large enough for high speed with no better heating means than a mere water-jacket, we will simply have an engine that will not operate a great part of the time when a man would like to drive his car. We were able to make airplane engines operate throughout a desirable range without heat on the manifold, because of the good grade of fuel used and the nature of the propeller load, which, when the engine speeds are low, permit running with partial throttle and more favorable evaporating conditions; but the same design would be absolutely impossible in a passenger or a commercial car with our present heavy fuels.

As previously stated, even distribution to the different cylinders of the liquid fuel content in the intake manifold is practically impossible at very low air speeds, while at extremely high speeds the fuel usually follows the air closely. There is a large intermediate range, however, through which the fuel distribution is quite definitely affected by the design and contour or map of the intake system, and in this analysis it is necessary to make a distinction between the effect of changes in contour and changes in area, which operate by varying the velocity. My own experience has probably been the same as that of most engineers, that in addition to the things we can understand about an intake manifold which affect distribution, there are a number of puzzling facts which we can scarcely account for at all; for one instance, the extraordinary effect that changing the order of firing may have upon the efficiency of a given manifold design. Some time ago we built a device by which we could blow a mixture of air and atomized water or gasoline through an intake manifold shape built in wood with one glass side. We also incorporated a hand or belt-operated set of valves so that the successive impulses of suction could be reproduced. With this we gained an entirely new idea of the action of the intake manifold and found what seemed to be a satisfactory explanation for a number of the anomalies we had observed.

The first thing we noticed was that, on account of the long distance and number of bends between the main carbureter passage and any given valve pocket, when the suction to a pocket begins, after having previously been inactive, the fuel does not immediately begin to flow through the valve, and by the time the flow of fuel drops and mixture has been established the valve closes, while the fuel piles up near the valve pocket and stops. On the next suction stroke this fuel, left over from the preceding one, goes in and another charge is drawn over from the carbureter passage ready to go in the next

time. In other words, it is entirely improbable that, at most operating speeds, the unevaporated part of any given fuel charge completes its journey from the carbureter nozzle to the cylinder during the same suction stroke that its air charge does.

We also seemed to find that whenever the fuel and air mixture comes to a tee or a point where the passage divides, and when there is a flow in one direction while the other division is inactive because its intake valve is shut, as a result of the eddy at this point a little pool of fuel is formed in the passage which is inactive. Then when the intake valve of the previously inactive cylinder opens, the sudden inrush of air draws in not only the fuel brought there by the previous air charge to this same cylinder but also the fuel deposited at the mouth of this individual passage by the suction of the neighboring cylinder. I think this is why we usually find that when the timing and design are such that two cylinders follow each other at unequal intervals in drawing from the same valve pocket, the one following the longer interval usually gets the richer mixture; of course, under the conditions of low velocity previously described. I would not say that the fuel literally drops down to the bottom of the manifold and forms a pool, because it does not always have time to do so; but it does stop moving, which gives, to a certain extent, a similar effect. A window in the intake manifold shows a rapid flicker of the atomized fuel, changing its direction back and forth, even when the walls of the manifold are dry.

I would like to be able to evolve a few rules by which an efficient intake manifold design could be made. But the problem is so complicated and the individual requirements of design so varied, that this is practically impossible. The only definite recommendation I can make is that before proceeding with the actual construction of an engine it would be well worth while to have a patternmaker construct a wooden model of the contemplated manifold to scale and in the exact position that the finished manifold will occupy, and then discharge a mixture of air and water through it and notice the action, with the cylinder ports opening in the order of firing. Much can be learned about the distribution by turning on the air in spurts of a second at a time as the valve ports open in succession. It will usually be found that there is a slight delay before any liquid fuel discharges from the ports, and the cylinders which are getting the richest fuel charge will respond most quickly and in the greatest volume. A great deal can also be told about the flow of the fuel by the manner in which it comes out of the port, whether at one side, the top or the bottom, or evenly distributed throughout the air column.

There are a few points of design which seem to apply more or less universally and may be worthy of enumeration here.

(1) When the design permits, no two valves should follow each other in the same pocket, unless they operate at equally spaced intervals of engine rotation
(2) The distance from a tee or point of division to each valve should as nearly as possible be the same. More important and less difficult to obtain, the angle of bend and amount of vertical rise should also be approximately the same. It is very bad to feed some cylinders out of the top of a manifold passage and others from a gradual rise at the ends
(3) Avoid any sudden enlargements, particularly in the vertical rise
(4) Make the bends of as large a radius as possible. The total resistance of the manifold to air-flow is the sum of the bend resistance and the straight passage resistance, and by easing up at the bends it is frequently possible to use a smaller diameter and higher velocity throughout, without decreasing the maximum power capacity
(5) Most important of all is the proper application of heat, to be discussed more fully in later paragraphs

The actual sizes will depend, of course, upon the intake velocities used, and these are contingent upon the heating. For the present-day motor-car engine, which is expected to operate on a range of full throttle of ten to one, I would make the intake manifold velocity not less than 250 ft. per sec. at the maximum normal operating speed,

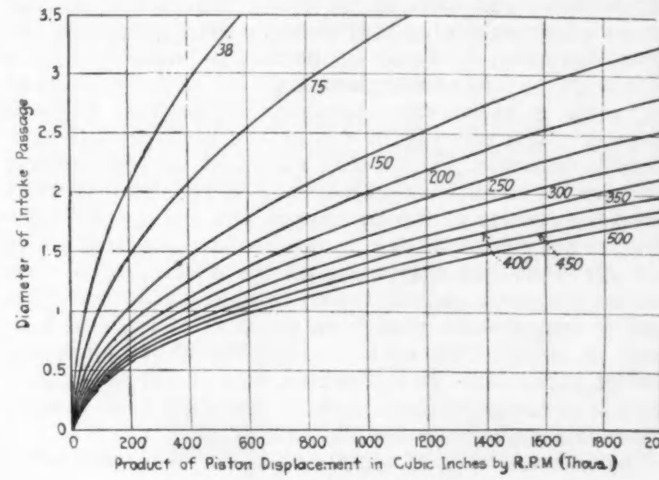


FIG. 1

and I would try one with 300 ft. per sec. If a properly designed hot-spot is used, it may be practical to decrease this velocity to 190 or 200 ft. per sec. without any loss in efficiency at low-speed pulling.

It will be noted that it is often very difficult to conform with these requirements, when the intake manifold is cast integrally in the cylinder block. With the grade of fuel available some years ago, inequalities in distribution could be compensated for by the rise in manifold temperature due to the water-jacket, but now the water temperatures are no longer adequate and the concessions which it is necessary to make to foundry practice nearly always prove seriously detrimental to the operation of the engine. There are a few engines whose performance proves that it is possible to secure a fair distribution with an "enbloc" manifold, but I am sure that in every case the performance would be even better if the manifold were properly built outside.

One thing which I shall personally avoid is spiral bends or ramshorn shapes, not because some of them have not been known to work well, because they very definitely have, but rather because of the difficulty of knowing in advance how they are going to work. The effects of gravity and of centrifugal force may either oppose each other or combine, according to the speed. In several cases we have spoiled the action of the engine to an extent almost unbelievable by the use of an improperly shaped spiral bend, and in one case we remedied the trouble by an alteration so slight as to be hardly noticeable. In fact, it was a change which had to be shown rather by a model than a drawing. I also prefer to make the manifold as nearly as possible in one plane, which permits a model to be made with one side of glass and usually works out to a neat appearance when finished.

One point to be taken into account is the effect of having the throttle, if of the ordinary butterfly type, near

a point of division. Care should be taken that the throttle in a partly open position does not deflect too much of the liquid fuel stream into one part of the manifold. Unless the point of division or tee is plain in shape and well heated, the throttle ought to be at least 4 in. below the tee; it is even preferable to have the throttle crosswise of the tee. We have nearly always had trouble when the tee bend had a deflecting corner in the center, what I might most easily describe as a Y-bend.

Application of Heat

The proper application of heat is difficult under ordinarily accepted limitations, because of the great range in temperature variation in the many different conditions under which an engine is operated. All of you know the great variation in water temperature encountered on a single spring or fall day; and the heat of the exhaust at any given point can vary more than 500 per cent, between closed-throttle running in winter and open-throttle running in summer. With this variation in temperature we have the condition that a rise of 50 deg. fahr. will cut down the density of the air charge, and the power, 10 per cent; and a rise of 30 deg. in the mixture temperature at low air velocities may make all the difference between perfect operation and continuous trouble. This sensitiveness to temperature change on the part of the fuel system, in conjunction with the very great temperature change encountered in the engine, is, I think, the reason so little progress has been made in the application of heat to our fuel systems in the last few years.

The different ways of applying heat may be enumerated as follows:

(1) Heating the fuel before it issues from the carbureter nozzle
(2) Heating the air charge
(3) Heating the intake manifold walls

As to the first we definitely and positively advise against any attempt to heat the fuel in the float bowl of the carbureter, because fuels in many sections of this country contain a small percentage of very volatile elements, casing-head gasolines being a sample. The amount of heat that is necessary in the carbureter to handle the heavier elements will make these light elements boil rapidly in the nozzle, which totally upsets the metering of the carbureter, causes the engine to backfire and practically makes the car unusable until the heat supply is removed.

Heating the air has the disadvantage that it applies equally or in greater measure to high-entering manifold velocities, when it is scarcely needed, than to low air velocities when it is most needed. This results in there being a considerable loss of power at high speeds, if the air supply is sufficiently heated to give good operation at low pulling speeds. Nevertheless, preheating the air to a certain degree is advantageous in all except hot summer weather, and I believe that the present practice of taking the intake air from a small heating chamber surrounding the exhaust pipe is about as effective as necessary and can scarcely be improved. It is, of course, necessary to provide a means for disconnecting the hot air by opening additional cold-air vents in hot weather or in hot climates; also in case of the possible use of casing-head gasolines.

The third method mentioned, of heating the manifold walls, appears to me to offer the greatest possibilities, because it seems to work out in practice that the delivery of heat to the fuel is most efficient when the air velocities are low, just when this action is needed, while at high velocities the effect is less marked. This, however, is only true if the design is properly made, for there are several very important considerations which must be followed. The heat must be applied only on a relatively small area and at points where the fuel gathers. It is well known that when the atomized mixture passes around a bend or through a tee, the heavy particles will go to the outside; also that, after the fuel is once condensed, it tends to follow the laws of gravity and seek the bottom of the passage. This, of course, means that the vertical above the carbureter, the outside of the bend or tee and possibly a small portion of the bottom of the passage just beyond the bend, are the places to heat. If these walls are heated to a temperature of 250 deg. or higher, the fuel particles will strike them and fly off or fry off as a fine fog or smoke and remain in this condition until the mixture reaches the cylinder. In order that this temperature may be quickly attained after starting, and in cold weather, it is necessary to take a considerable portion of the exhaust heat. This we have obtained by heavy ribs projecting into the exhaust passage and by making sure in all cases that the exhaust circulates through these ribs. To keep from getting too much heat in summer under full load with this effective method of heating, it is absolutely necessary as previously stated that the heating area be confined wholly to the places enumerated above, where the heavy fuel particles strike. A good rule is $1\frac{1}{2}$ sq. in. of heating surface to each 50 cu. in. of piston displacement. To hold the fuel at this point longer and insure a more complete heating at low temperatures, ribs or baffles are provided to obstruct the flying off of the particles.

Fig. 2 shows an elbow heated by this method. The carbureter is attached at the bottom and the mixture is delivered horizontally to the intake manifold at the right, while the exhaust comes in at the top and escapes at the left.

Fig. 3 shows the same construction applied to the tee of the intake manifold. The exhaust enters from the top and escapes to the rear through an outlet which is not shown. In both these cases it is advisable to make the exhaust connection as short and direct as possible, and the larger the size the better. However, the exhaust outlet can be small, a ¾-in. iron pipe being ample in size. With this size pipe, perhaps on account of the cooling and the baffling effects of the ribs, the sound of the exhaust escaping through this passage is scarcely noticeable.

Fig. 4 shows an attachment that is badly needed on many of the present-day motor trucks. To obtain a good governor location and gravity feed to the carbureter, the latter is frequently mounted very low with a cold vertical section of the intake passage 1 ft. or more long, which acts as a natural condensing chamber for the fuel. This illustration shows a heating element, to be located between the governor and the carbureter, in which the exhaust is passed through a central cross-tube over which the intake charge must pass and upon which the gasoline particles will strike. The axis of the throttle should be crosswise to the direction of the tubular passage, as shown, so that at partial throttle openings the fuel will be sure to strike the heated surface.

A very important point about the installation of such a device is that the exhaust must actually reach the hot-spot. If the piping from the exhaust manifold to this point is 1 ft. or more in length, the natural resistance of the line will be high in proportion to the main exhaust pipe and very little exhaust will pass through it, with the result that it will not heat up with closed-throttle

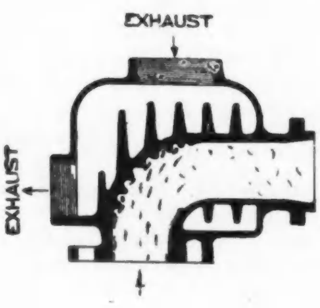


FIG. 2

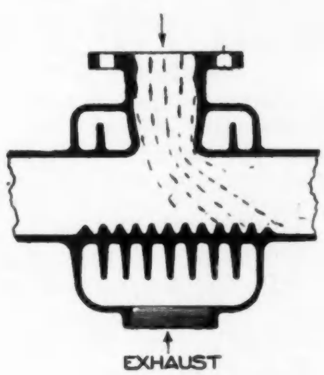


FIG. 3

operation, but only after the engine has been pulling hard. Therefore, when the pipe to the hot spot is necessarily long it should be made as large as possible, 1½ to 2 in. in diameter, and protected from any loss of heat, either by wrapping the outside with asbestos or by putting an additional outer sheet metal or flexible tubing casing around the outside. It will probably be found necessary also to restrict the main exhaust line by a bushing or flat plate with a hole in it, to about the same size so that at least half of the exhaust will pass to the hot spot. It is remarkable how *very little* heat will pass through a long pipe connected into the exhaust manifold, unless some additional restriction is placed beyond this connection in the exhaust line. Inasmuch as the average exhaust line could be reduced to one-quarter of its area without either affecting the power or overheating the engine, it is perfectly safe to make the above restriction in the main exhaust outlet.

Improved Operation Secured

The use of these devices has improved extraordinarily the operation of a number of cars upon which we have tried them. We have been able to make six-cylinder engines warm up very quickly in the coldest weather. As the hot-spot is so limited in area it does not heat the intake charge more than 20 to 30 deg. fahr. and we have actually had a gain in power instead of a loss, probably because of better distribution and the fact that it was possible to use lower manifold velocities with less reduction of volumetric efficiency. The fuel economy is very much better indeed, both because the carbureter can be adjusted much "leaner" and because the dash-control of the mixture is used so little. Another reason the economy is better is that the engine remains in better condition. There is less carbon deposit, almost no spark-plug or ignition trouble, and it is no longer necessary to change the lubricating oil every two or three weeks. I firmly believe that three-fourths of the service work performed on passenger cars and motor trucks today would be eliminated if their intake system were modified along these lines.

I believe and hope that the time is coming when the service departments of each responsible motor-car and motor-truck manufacturer will develop fittings and connections of the nature indicated to replace the equipment of cars now in service. After the patterns and tools are once made the cost of production is low and the application could probably be made in half a day, so that the complete installation should not cost over $10 or $15. I know of no other way in which an equal gain in operation, satisfaction and efficient service can be obtained for three to four times the price, and I am sure that the company which first makes the effort will be well rewarded.

One serious difficulty is often encountered in the application of a hot-spot to present cars, the difficulty of piping exhaust heat across an engine when the carbureter and exhaust manifold are on opposite sides. To make the exhaust pass through this branch it is necessary that it be almost as large in capacity as the main exhaust line, which leads to expense and to difficulties in silencing. We are making experiments as to the amount of restriction that can be placed upon the exhaust line to force heat across an engine in this way, but at present I can only say that in every case where it is possible to do so the carbureter should be placed on the same side of the engine as the exhaust manifold.

The Discussion

Paul Kroesing:—Many engineers advance the theory that when there are too many hot-spots at the intake, the pressure in the cylinder is reduced.

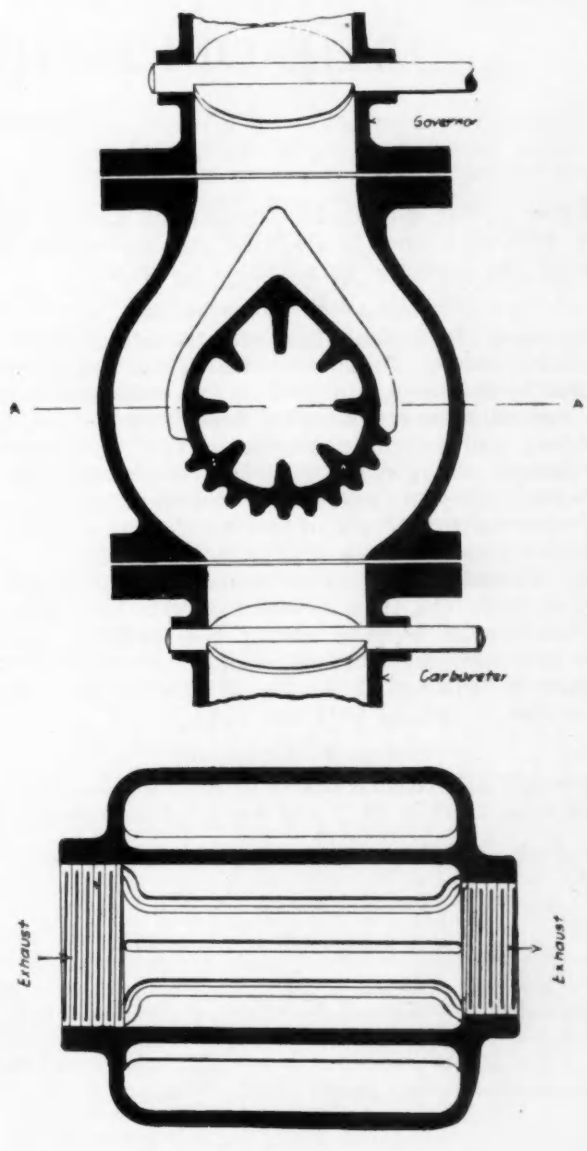


FIG. 4

MR. MOCK:—Yes, if the hot-spots are too large. Sheet metal cannot possibly get too hot as long as liquid is on it.

G. W. SMITH:—A new device with many little pockets is being made for the Nash engine. The light fuel goes through and the heavy drops into the pockets which are heated. The heavy immediately fries up and joins the light fuel, and every portion of fuel is thus utilized.

J. G. ZIMMERMAN:—Several years ago it occurred to us that by treating fuels chemically great improvements could be made, but this idea was suppressed. Nevertheless this process is coming and the supply of fuels now available will soon be enlarged by chemical treatment. Then the study of heating the manifold must be repeated and changes made to apply to the new fuels. Experiments made at Washington were very satisfactory in spite of statements to the contrary made by the Fuel Administration. With chemically treated fuels used in the proper way, greater mileage can be obtained than with the highest grade of gasoline now produced.

W. G. GERNANDT:—How do such fuels work in cold weather?

MR. ZIMMERMAN:—The fuels were of summer grade, but the treatment can without difficulty be controlled to produce any desired fuel. This is a new field that will bear the closest investigation. A great many devices now necessary while using present-day fuels will be supplanted.

D. S. HATCH:—Is there a possibility that such fuels will be put upon the market commercially?

MR. ZIMMERMAN:—Plans for the largest working plants are complete and experimental plants for producing 2000 gal. per day are ready now.

C. B. PAGE:—Has the use of steam really accomplished any great effect or any advantage over the hot-spot?

D. L. ARNOLD:—I once had an idea that steam would be a good thing and made an experiment on a two-cylinder engine. I put a jacket on it and tried to take all the steam into the engine. It did not work. It reduced the horsepower from 60 to 45.

THE OFFICERS OF THE SOCIETY

(*Concluded from page* 152)

Division of the Standards Committee. He has had a very wide experience in electrical and mechanical engineering and research work related thereto.

CHARLES B. WHITTELSEY

Treasurer Whittelsey has been connected with the Hartford Rubber Works Co. since 1901, beginning as its purchasing agent. In 1905 he was made assistant to the general manager, in 1906 superintendent, in 1911 secretary and factory manager, in 1915 vice-president and factory manager, and in 1916 president and factory manager. He was president of the Hartford Chamber of Commerce in 1914 and of the Hartford County Manufacturers' Association in 1917 to 1919, inclusive.

Mr. Whittelsey was elected to membership in the Society in 1910. In 1916 he was elected a Life Member. He has been a member of the Standards Committee since 1911 and served as chairman of the Tire and Rim Division in 1918 and 1919. Mr. Whittelsey was a member of the Council in 1912 and 1913.

COKER F. CLARKSON

Secretary and General Manager Clarkson was born at Des Moines, Iowa in 1870, and was graduated from Phillips Exeter Academy in 1888. In 1889 he was in Government service in the Post Office Department. He was graduated from Harvard College in 1894, pursuing postgraduate work there for the next two years. He was next engaged in connection with the installation of an underground telephone system in Philadelphia for two years, after which time he came to New York and spent several years in work on technical, legal, patent, laboratory and automobile subjects. From 1905 to 1910 he was connected with the Association of Licensed Automobile Manufacturers, as secretary of its Mechanical Branch, publicity manager and assistant general manager. During this time he was the editor of the A. L. A. M. Mechanical Branch Bulletins and of the A. L. A. M. weekly digest of current technical literature.

Mr. Clarkson has been secretary and general manager since 1910, first of the Society of Automobile Engineers and then of the Society of Automotive Engineers when the latter was formed.

During the war Mr. Clarkson was associated with the Council of National Defense, and served as a member of the automotive products section of the War Industries Board, and the International Aircraft Standards Board.

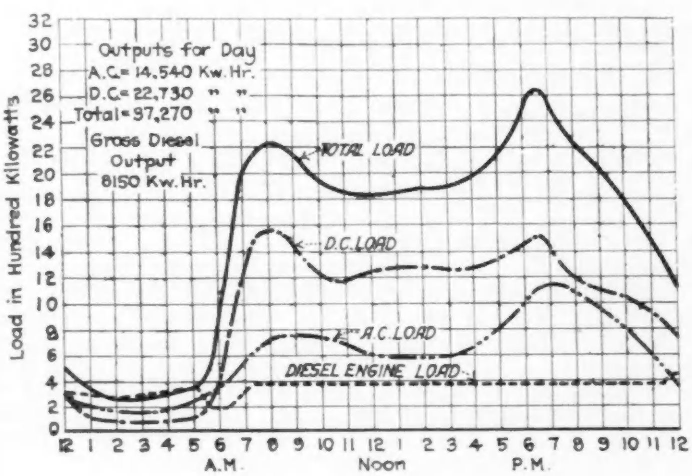
Diesel Engines Economical in a Central Station

THE following results, according to a recent number of *Power*, were obtained in the plant of a traction company in the Middle West operating about 70 miles of electric railway lines together with an extensive lighting, power and steam-heating business, and serving a city of more than 60,000 population and its various suburbs.

In addition to the local lighting business the company supplies lighting service to from 10,000 to 12,000 suburbanites, the farthest point reached being about six miles from the powerplant.

The company operates about 2 miles of steam heating mains, a 16-in. main from the station reaching practically all of the downtown retail district and serving theaters, churches, department stores, etc. Practically all of the steam is low-pressure exhaust from the engines. Steam from the bleeder-type turbine and live steam are seldom needed. Typical load curves for the years 1917, 1918 and 1919 are reproduced herewith.

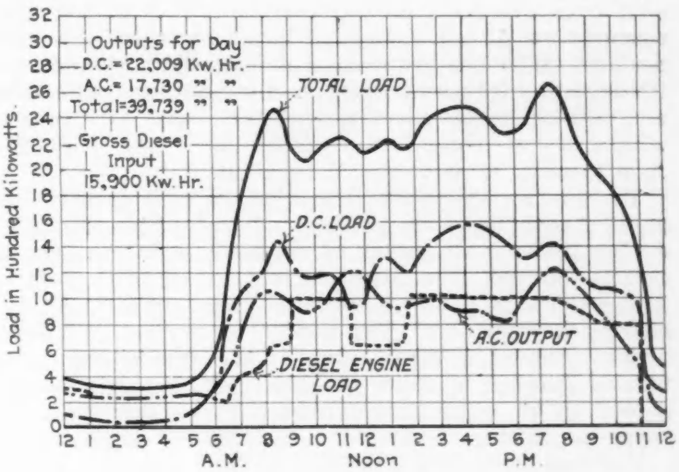
The operating powerstation equipment in 1915 included a 750-kw. turbine, a 500-kw. engine, a 325-kw. engine, a 1500-kw. turbine and a 500-kw. turbine. There was also one 200-kw. high-speed engine not in use. The boiler room equipment included six 250-hp. and two 450-hp. boilers equipped with underfeed stokers, one 150-hp. boiler equipped with blowers and two 500-hp. boilers equipped with chain grates. In 1916 the lighting demand increased considerably and the demand for steam heat increased more than 20 per cent. The boiler room had reached the limit of its output and it became necessary either to increase its capacity or to obtain energy from some other source. A study of the Diesel engine led to the conclusion that the necessary increase in plant capacity could be obtained without increasing the boiler room capacity by adding engines of this type, with an increase in efficiency of the plant as a whole.



LOAD CURVE FOR AN AVERAGE DAY IN 1916

INITIAL EQUIPMENT PURCHASED

Two four-cylinder, vertical, 500-hp. Diesel engines, operating at 200 r.p.m. were, therefore, installed in

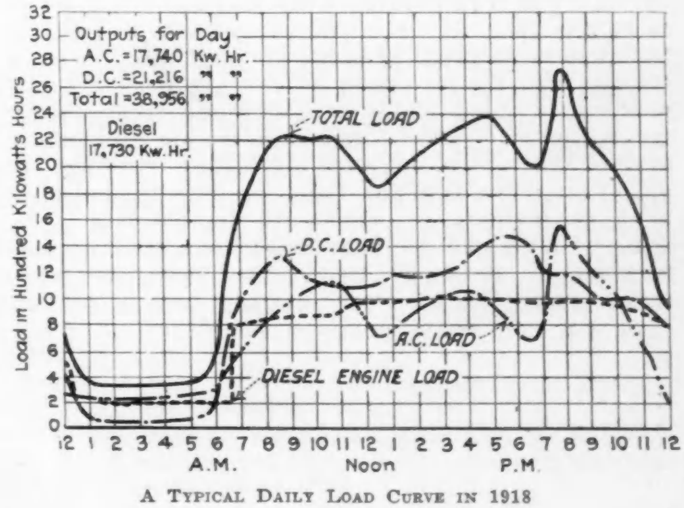


TYPICAL CURVE OF THE DAILY LOAD IN 1917

August, 1916. One is direct-connected to a 350-kw. 2300-volt 60-cycle three-phase alternating-current generator and the other to a 350-kw. 550-volt direct-current generator. The guarantees for these engines provide that with a net load of from 500 b.hp. to 250 b.hp. the fuel-oil consumption will not exceed 6 gal. per 100 b.hp.-hr. to 7.4 gal. per 100 b.hp.-hr for the two loads mentioned, respectively; the fuel oil to have a heat value of not less than 18,500 B.t.u. per lb., specific gravity at 60 deg. fahr. not higher than 20 deg. Baumé and not lower than 40 deg., with residue not more than 10 per cent. The speed variation from no load to full rated capacity is not to exceed 2½ per cent from mean.

When the Diesel engines were installed, the 1500-kw. mixed-pressure turbine, using low-pressure steam from the engines and high-pressure live steam when necessary, was sold because uneconomical, and a 1500-kw. 2300-volt bleeder-type turbine, operating at 3600 r.p.m., was installed on the same foundation.

In November, 1917, one four-cylinder, vertical-type, 500-hp. Diesel engine having a normal speed of 164 r.p.m.



A TYPICAL DAILY LOAD CURVE IN 1918

was installed. This is direct-connected to a 350-kw. 550-volt direct-current generator. The maker guarantees that this engine, when carrying between full and one-quarter net load will consume fuel oil of a heat value of not less than 18,500 effective B.t.u. per lb. not to exceed a range between 0.408 lb. and 0.628 lb. per b.hp. per hr. The speed variation is guaranteed not to exceed 3 per cent from mean for normal variations in load, and the consumption of lubricating oil is not to exceed 2½ gal. per day. With the installation of the third Diesel engine the reserve high-speed steam engine was removed and a new 500-kw. motor-generator set was installed together with a 50-kw. motor-driven exciter set. This has sufficient capacity to serve the entire plant.

The alternating-current Diesel-engine unit operates in parallel with the 1500-kw. turbine, and after midnight during the summer season, when there is no heating, it carries the load. The direct-current Diesel units operate in parallel with the direct-current steam engines and the motor-generator sets. The alternating-current unit frequently carries a direct-current railway load by conversion through a motor-generator set, but it was installed as an alternating-current unit so that it could carry the lighting load after midnight.

The fuel oil is delivered in tank cars on a spur track and unloaded by gravity to two underground steel drum storage tanks with a capacity of 12,000 gal. each. From the tanks it is pumped by small motor-driven pumps, supplemented by an auxiliary hand-pump for emergency use, through piston-type oil meters to auxiliary 30-gal. supply tanks located on the wall, about 6 ft. above the fuel-oil pumps. Fuel pumps on the engines draw the oil from the auxiliary tanks and feed it, according to the position of the governor, through discharge lines to the needle valves.

Cooling Water System

Another important feature is the cooling water for the engine. This is pumped from wells just outside the plant to a 16 by 16-ft. tank located on the roof of the plant. The pumps are of the vertical centrifugal type, direct-connected to motors and located in the wells close to the water level. From the supply tanks the water passes by gravity to the jacket on the engine cylinders, exhaust valves and air compressors and drains to a tank in the basement of the engine room. Thence by a small horizontal, motor-driven pump, approximately 100 gal. per min. is carried back to the supply tank on the roof. This return of part of the cooling water to the original supply is a feature added some time after the installation of the engine. The temperature of the well water is from 50 to 55 deg. fahr. It was at first found that this was so low as to cause sweating in the air compressor owing to the fact that the air drawn in from the room is at approximately 72 deg. and is moist from the steam-generating equipment. Water forming in the air compressors drained and washed out some lubricating oil. The 100 gal. of water per min. now returning from the basement at a temperature of about 110 to 125 deg. fahr. mixes with the cold well water and gives a resultant temperature of 70 to 80 leg., approximately the room temperature. The air intake has now been placed outside the building and all entering air passes through flannel strainers, thus eliminating all dirt and furnishing air not laden with moisture from the steam equipment.

The water from the company wells is very salty. It could not be used for piston cooling in the earlier engines because when heated the water formed a scale which destroyed the efficiency of the cooling operation. City water is used for this purpose and is regulated to 38-lb. per sq. in. pressure. The water purchased from the city also contains scale-forming materials and if raised to a temperature sufficiently high will in cooling deposit a scale which requires an occasional sulphuric-acid bath to remove. Failure to remove this scale is likely to result in cracked pistons, and failure to remove the scale from the cooling passages in the cylinder-heads will cause these to crack due to the fact that the cooling is not properly performed if the passages are filled with scale.

Output and Costs of Operation

The accompanying table gives data on the operation of the plant for the years 1915 to 1918 inclusive.

	1915	1916	1917	1918
Kilowatt-hours generated	10,776,910	11,531,890	12,613,994	12,907,625
Kilowatt-hours used by railway	6,161,741	6,194,657	6,180,776	6,076,431
Kilowatt-hours used for light and power	4,615,169	5,337,233	6,433,218	6,831,194
Pounds of steam sold	68,588,000	83,499,000	92,728,700	75,643,000
Kilowatt-hours generated by steam	10,776,910	10,062,180	8,309,057	8,291,539
Tons of coal used	38,411.51	42,652.19	35,736.17	31,110.43
Average cost per ton	$2.87	$3.50	$4.59	$4.96
Pounds of coal per kilowatt-hour	7.13	8.48	8.60	7.50
Cost of coal per kilowatt-hour, cents	1.02	1.48	1.97	1.86
Total cost of coal	$110,339.57	$149,271.05	$163,938.99	$154,329.60
Kilowatt-hours generated by Diesel engines	None	1,469,710	4,242,377	4,616,086
Gallons fuel oil used	None	136,664	395,568	427,967
Average cost per gallon of oil, cents	None	3.14	3.70	5.66
Kilowatt-hours generated per gallon of oil	None	10.70	10.70	10.70
Cost of oil per kilowatt-hour, cents	None	0.292	0.345	0.566
Total cost of fuel oil	None	$4,294.12	$14,646.77	$24,238.99
Total fuel cost (oil and coal)	$110,339.57	$153,565.17	$178,585.76	$178,568.59
Average cost of fuel per kilowatt-hour, cents	1.02	1.33	1.41	1.38
Wages of power-station employes	$20,967.92	$24,797.08	$27,029.13	$39,230.33
Cost of water	7,839.49	9,699.51	7,424.19	8,711.05
Cost of lubrication	1,127.08	2,404.24	3,851.77	4,991.90
Cost of power purchased	317.26	386.32	1,898.75	....
Miscellaneous expense	1,902.42	2,134.75	2,761.34	3,548.71
Power-plant maintenance cost	13,136.66	11,891.43	20,179.56	25,376.53
Total cost of power-station operation	155,630.40	204,878.50	241,730.50	260,517.11
Switchboard cost per kilowatt-hour, cents	1.44	1.78	1.91	2.02

It will be noted that in 1917 and 1918 the Diesel engines carried more than one-third the load of the plant; also that the cost of coal per kilowatt-hour generated in 1918 was 1.86 cents, while the cost of oil per kilowatt-hour generated was only 0.566 cent. Part of this difference is offset by the increased cost of maintenance of the Diesel engines as compared with the steam units and by the fact that the coal cost also includes that of the coal used for heating, but there is an estimated saving of at least 0.9 cent per kw.-hr. on all energy generated by the Diesel units. As this amounted to 4,616,086 kw.-hr., the saving was more than $41,000 in 1 year on switchboard cost.

ACTIVITIES OF THE SECTIONS

(*Concluded from page 179*)

members and guests who were present were unanimous in their appreciation.

Minneapolis Section: In its regular series of monthly meetings this Section is specializing on the design of a general-service tractor. This is being worked out by a ballot or questionnaire which is filled out by each of the members, giving his preferences as to the type of the respective part. At each meeting a different part of the tractor is taken up and the result is something like a consensus of opinion of the members of this Section as to what should be incorporated in the design of a tractor. At the December meeting held at the Manufacturers' Club, Minneapolis, papers were presented by A. W. Scarratt, who spoke on the comparative merits of wheels with various types of tread, and by A. M. Leoni, who described the P-T wheel. E. R. Nash spoke of tractor cultivation in the fruit area of California and mentioned the prevailing need of a low machine because of the small clearance under fruit trees. At the January meeting the relative advantages of the Four-Wheel and Caterpillar Drives were considered.

Metropolitan Section: The Section held a meeting with the local sections of the American Society of Mechanical Engineers and the American Institute of Mining and Metallurgical Engineers, on Feb. 10, at which G. M. Rollason, assistant director of Aluminum Manufactures, Inc., presented a paper on Alloyed Aluminum as an Engineering Material. The processes of forging and welding aluminum were discussed, as well as the improvements which had taken place in the field of die casting. The necessity of a farsighted analysis of the future demand for aluminum was mentioned because of the length of time necessary to develop new sources of supply.

Future Meetings

The Metropolitan Section will hold a meeting on April 8 at the Automobile Club of America, at which A. F. Masury of the International Motor Co. will present a paper on Tire Deflection and Unsprung Weight in Trucks, which will be illustrated by moving pictures. On May 13, L. G. Nilson will give a review of the piston-ring art, dealing with piston-rings which have been developed and those which are now in use, with a discussion of the advantages and disadvantages of the various types.

The next meeting of the Indiana Section will be on April 30, at the Claypool Hotel, Indianapolis, at which the speaker will be Past-president Charles F. Kettering.

The Pennsylvania Section will hold a meeting on April 22, at the Engineers' Club, Philadelphia, at which the speaker will be Past-president Charles F. Kettering. The May meeting will be a spring outing, the details of which will be announced later.

The next meeting of the Council of the Society will be in Chicago on Friday, April 9. The Mid-West Section will hold its April meeting on the evening of the same day. Arrangements have been made for a dinner which will precede the meeting of the Section.

Nominations for Officfrs

The following nominations for Section officers have been received up to the time of going to press:

BUFFALO SECTION

Chairman, C. F. Magoffin
Vice-chairman, E. T. Mathewson
Secretary, R. Chauveau
Treasurer, J. C. Talcott

CLEVELAND SECTION

Chairman, H. G. Welfare
Vice-chairman, H. C. Snow
Secretary, A. E. Jackman
Treasurer, K. B. Britton

DETROIT SECTION

Chairman, E. G. Gunn
Vice-chairman, Howard A. Coffin
Secretary, M. Howard Cox
Treasurer, E. W. Seaholm

METROPOLITAN SECTION

Chairman, A. M. Wolf
Vice-chairman, A. C. Bergmann
Secretary, M. C. Horine
Treasurer, L. G. Nilson

PENNSYLVANIA SECTION

Chairman, G. W. Smith, Jr.
Vice-chairman, A. K. Brumbaugh
Secretary, H. Hollerith, Jr.
Treasurer, J. T. O'Neill.

PERSONAL NOTES OF THE MEMBERS

R. M. Bean and A. C. Bryan, sales manager and factory manager respectively of the Durston Gear Corporation, Syracuse, N. Y., were elected directors and vice-presidents at a recent meeting of the stockholders.

Walter E. McKechnie, who was associated with the Cadillac Motor Car Co., Detroit, Mich., for 12 years as electrical and factory engineer, has accepted the position of factory engineer with the American Electrical Heater Co., also of that city.

H. A. Oswald, chief engineer of the Quaker City Corporation, Philadelphia, Pa., has returned from Cuba after a stay of 4 months.

M. M. Risberg, who was formerly comptroller of the Republic Motor Truck Co., Alma, Mich., is now connected with L. V. Estes, Inc., Chicago, Ill.

J. A. Tarkington has resigned as superintendent and consulting engineer of the Kissel Motor Car Co., Hartford, Wis., and is now vice-president and factory manager of the Tarkington Motor Car Co., Rockford, Ill.

C. F. Taylor has accepted a position in the engineering department of the H. H. Franklin Mfg. Co., Syracuse, N. Y. He was formerly assistant engineer in the powerplants laboratory of the Air Service at McCook Field, Dayton, Ohio.

S. R. Thomas is now assistant chief engineer of the Jordan Motor Car Co., East Cleveland, Ohio. He was previously connected with the engineering department of the Central Division of the General Motors Corporation and the Hudson Motor Car Co., both of Detroit, Mich.

W. R. Vohrer, who served in the Motor Transport Corps with the rank of second-lieutenant, has accepted a position in the ordnance engineering laboratory of the Holt Mfg. Co., Peoria, Ill.

Spencer Welton has resigned as president of the Sterling Tire Corporation, Rutherford, N. J.

C. H. Wood has severed his connection with the National Tube Co., Pittsburgh, Pa., to accept a position with the Ohio Seamless Tube Co., Shelby, Ohio.

Applicants *for* Membership

The applications for membership received between March 1 and March 22, 1920, are given below. The members of the Society are urged to send any pertinent information with regard to those listed which the Council should have for consideration prior to their election. It is requested that such communications from members be sent promptly.

AMADON, CHARLES S., broach designer, 52 Gorton Street, *New London, Conn.*

BANTA, C. E., sales manager, Adams & Westlake Co., 319 West Ontario Street, *Chicago, Ill.*

CHILDERS, FOUST, assistant supervisor of assembly, Remy Electric Division, General Motors Corporation, *Anderson, Ind.*

CLAUSEN, DEWITT, designer, Service Motor Truck Co., *Wabash, Ind.*

CONNOLLY, JAMES H., consulting engineer, Capital Motors Corporation, *Fall River, Mass.*

COX, M. HOWARD, manager district office, Fafnir Bearing Co., *New Britain, Conn.*

CRECELIUS, HENRY R., body engineer and designer, Brewster & Co., *Long Island City, N. Y.*

CUMMING, WILLIAM J., designer, Goodyear Tire & Rubber Co., *Akron, Ohio.*

DEIN, GEORGE H., chief engineer, Equitable Auto Mfg. Co., 248 West Sixtieth Street, *New York City.*

DOWNS, CYRIL WINFRED, inspector of machined parts for gasoline engines, Pittsburgh Model Engine Co., *Pittsburgh, Pa.*

DUNN, WILLIAM C., chief engineer, H. J. Walker Co., *Cleveland, Ohio.*

DURLAND, H. S., student, Pratt Institute, *Brooklyn, N. Y.*

EDWARDS, CLARENCE, chief draftsman, Bethlehem Motors Corporation, *Allentown, Pa.*

FAIRCHILD, SHERMAN M., president, Fairchild Aerial Camera Corporation, *New York City.*

FINCH, NATHANIEL A., JR., supervisor, American Can Co., 120 Broadway, *New York City.*

FLOWER, ROSWELL P., assistant manager of sales, Standard Steel Castings Co., *Cleveland, Ohio.*

FRASER, HARRY, engineering department, Oakland Motor Car Co., *Pontiac, Mich.*

GALLOWAY, JAMES W., designer, Packard Motor Car Co., *Detroit, Mich.*

GILL, THOMAS B., sales engineering, Firestone Tire & Rubber Co., *Akron, Ohio.*

GRAHAM, JOHN, president, Paragon Tool Co., 610 East Pine Street, *Seattle, Wash.*

GREGG, DAVID, military aviator, 5 Bartlett Crescent, *Brookline, Mass.*

GUNDER, VIRGIL LUVERN, instructor in electrical department, Iowa State College, *Ames, Iowa.*

HACKETT, CLYDE O., draftsman, National Motor Car & Vehicle Corporation, *Indianapolis, Ind.*

HALE, R. F., in charge of salvage department, Holt Mfg. Co., *Peoria, Ill.*

HAUFLER, ARTHUR F., layout draftsman, National Motor Car & Vehicle Corporation, *Indianapolis, Ind.*

HIPPE, H. P., engineer, Hippe-States Co., *Des Moines, Iowa.*

HOOD, DONALD T., sales manager, Hood Rubber Co., *Watertown, Mass.*

KIRSCHMANN, JOSEPH, research engineer in district office, Ordnance Department, *Detroit, Mich.*

KLINGHOLZ, C. O., production engineer, Shaw Association, Ltd., *Chicago, Ill.*

LANDSITTEL, C. H., general manager, Paragon Motor Car Co., *Cleveland, Ohio.*

LARGE, FRANK EARL, second vice-president in charge of engineering, Johnson Rim & Parts Co., Inc., 2519 Delaware Avenue, *North Tonawanda, N. Y.*

LEAKE, THOMAS C., engineer, Bear Tractor Corporation of America, *Bridgeport, Conn.*

LEFEVRE, A. T., truck engineer, Firestone Tire & Rubber Co., *Akron, Ohio.*

MCLEOD, GEORGE D., chief lubrication engineer, Sinclair Refining Co., *Chicago, Ill.*

MORAND, JOSEPH J., president, Morand Cushion Wheel Co., 822 South May Street, *Chicago, Ill.*

MORE, ARTHUR S., president and general manager, Denby Motor Truck Co., *Detroit, Mich.*

NICKELSEN, J. M., engineer, Buick Motor Co., *Flint, Mich.*

NOAKES, WILLIAM E., automotive engineer, service division, Motor Transport Corps, *Washington.*

OHMER, ROBERT F., sales manager, Recording & Computing Machines Co., *Dayton, Ohio.*

OLBETER, M., engineer, Commercial Car Unit Co., Sixteenth Street and Glenwood Avenue, *Philadelphia, Pa.*

OLIVER, GEORGE R., designer, General Motors Truck Co., *Pontiac, Mich.*

O'NEILL, J. T., assistant sales manager, Standard Steel & Bearings, Inc., *Philadelphia, Pa.*

PAGE, RAYMOND D., draftsman, Brown & Fear, automotive engineers, 205 Oakland Bank of Savings Building, *Oakland, Cal.*

PARKER, JESS, chief inspector, Jordan Motor Car Co., East 152nd Street, *Cleveland, Ohio.*

PETERS, O. M., general superintendent, Emerson-Brantingham Co., *Rockford, Ill.*

RAPIN, EDWARD A., layout draftsman, Oakland Motor Car Co., *Pontiac, Mich.*

RIES, KURT FREDERICK, chief engineer, Recording & Computing Machines Co., *Dayton, Ohio.*

ROWE, CHARLES O., district representative, Hess Steel Corporation, *Baltimore, Md.*

SPAHR, DION G., production and service engineer, Pence Automobile Co., *Minneapolis, Minn.*

SPOONER, ROBERT HENRY, experimental engineer, Winton Co., *Cleveland, Ohio.*

STEVENSON, ARTHUR, president, American Automotive School, *Dallas, Texas.*

STOUT, HENRY S., metallurgist, Air Service, Box 1033, *Dayton, Ohio.*

SWENSON, S. R., chief engineer, radiator division, Marlin-Rockwell Corporation, *New Haven, Conn.*

TRIPP, L. L., president, Albany Boat Corporation, *Watervliet, N. Y.*

TUCKER, JOHN O., district sales manager, La Belle Iron Works, *Steubenville, Ohio.*

TYKEN, J. G. H., draftsman, Fageol Motors Co., 107th Avenue and Holywood Boulevard, *Oakland, Cal.*

WEBB, W. L., engineer, Crossley Brothers, Ltd., *Openshaw, Manchester, England.*

WELLS, MILTON HOWARD, assistant to the president, W. H. Allison Co., *Detroit, Mich.*

WERRA, CONRAD, president, Werra Aluminum Foundry Co., *Waukesha, Wis.*

WILLIAMS, HARRY, draftsman, International Motor Co., *New York City.*

WILLIAMS, JOHN M., JR., engineer, Willys Corporation, *Elizabeth, N. J.*

WILLIAMS, LAWRENCE S., chief draftsman, Borge & Beck Co., 6558 South Menard Avenue, *Chicago, Ill.*

WILLS, JOHN H., general manager and secretary and treasurer, John H. Wills Carburetor Co., 358 Belleville Avenue, *Newark, N. J.*

WILLSON, ERNEST M., mechanical engineer, Hart-Parr Co., *Charles City, Iowa.*

WINDFELDER, C. W., salesman, Carpenter Steel Co., *Reading, Pa.*

WOLNICK, HENRY F., general superintendent, American Car & Foundry Co., 2503 South Wood Street, *Chicago, Ill.*

WRIGHT, CECIL, draftsman, International Harvester Co., 2600 West Thirty-first Boulevard, *Chicago, Ill.*

YOUNG, HUGO H., general manager, Flexible Co., *Londonville, Ohio.*

ZIMMERMAN, THOMAS, chief engineer, Standard Parts Co., *Cleveland, Ohio.*

Applicants *Qualified*

The following applicants have qualified for admission to the Society between Jan. 4 and March 6, 1920. The various grades of membership are indicated by (M) Member; (A) Associate Member; (J) Junior; (Aff) Affiliate; (E S) Enrolled Student; (S M) Service Member; (F M) Foreign Member.

ALBERTY, FREDERICK (A) mechanical supervisor, Master Trucks, Inc., *Chicago, Ill.* (mail) 8606 Racine Avenue.

ALLINGHAM, HENRY W. (M) consulting production engineer, (mail) Manor Sharston Northender, *Cheshire, England.*

BARBER, LOUIS (M) mechanical engineer, National Screw & Tack Co., East Seventy-fifth Street and Stanton Avenue, *Cleveland, Ohio.*

BARLING, WALTER HENRY (M) aeronautical engineer, engineering department, Air Service, McCook Field, *Dayton, Ohio,* (mail) 9 Cornelia Apartments, Negley Place, Dayton View.

BARTON, CLARENCE H. (M) designer, Weidely Motors Co., *Indianapolis, Ind.* (mail) 430 East Forty-eighth Street.

BATHRICK, C. E. (M) vice-president and general manager, South Bend Motor Co., Linden Avenue and Anthony Street, *South Bend, Ind.*

BATTY, EDWARD G. (J) draftsman, McCord Mfg. Co., *Detroit, Mich.* (mail) 161 Pingree Avenue.

BEAL, FAY C. (A) chief engineer, Auto Truck Tractor Syndicate, 414 Insurance Exchange Building, *San Francisco, Cal.*

BEANS, JOHN F. (M) president and general manager, Beans Spring Co., *Massillon, Ohio.*

BECKLEY, HARRY E. (A) salesman, Beckley-Ralston Co., *Chicago, Ill.* (mail) 1834 Prairie Avenue.

BENEDICT, EDWARD L. (M) mechanical engineer in charge of the tractor department, Smith, Hinchman & Grylls, *Detroit, Mich.,* (mail) 185 Highland Avenue, Highland Park.

BERRY, O. C. (M) professor of automotive engineering, Purdue University, *West Lafayette, Ind.* (mail) 633 Russell Street.

BETZ, IRVING K. (M) president, Betz Motor Truck Co., *Hammond, Ind.*

BIDDLE, H. J. (J) assistant inspection engineer, Remy Electric Division, General Motors Corporation, *Anderson, Ind.,* (mail) Y. M. C. A.

BIGELOW, W. C. (A) sales manager, Yale & Towne Mfg. Co., Stamford, Conn. (mail) 105 Paine Avenue, *New Rochelle, N. Y.*

BLONQUIST, GUY L. (J) draftsman, U. S. Ball Bearing Mfg. Co., *Chicago, Ill.* (mail) 4149 South Michigan Avenue.

BOCK, CARL J. (J) tractor designer, Holt Mfg. Co., Peoria, Ill. (mail) 5-127 "B" Building, Sixth and B Streets, *Washington.*

BRADLEY, EDWIN P. (J) layout draftsman, L. H. Pomeroy, *Cleveland, Ohio.* (mail) 1845 East Nineteenth Street.

BRAND, MAURICE B. (J) designing draftsman, American Sleeve Valve Motor Co., *New York City,* (mail) 723 East Sixth Street.

BURDICK, JOHN S. (M) vice-president in charge of engineering, Buffalo Body Corporation, 125 Hardwood Place, *Buffalo, N. Y.*

BUSH, H. F. (M) president and general manager, Auto Equipment & Service Co., Inc., *Philadelphia, Pa.,* (mail) 1421 North Broad Street.

BUTTERFIELD, CLAYTON W. (M) sales manager, Dyneto Electric Corporation, *Syracuse, N. Y.* (mail) 737 Euclid Avenue.

CALL, C. A. (M) general sales manager, Federal Corporation, *Westfield, Mass.*

CAMPBELL, ROBERT S. (J) service department, Pittsburgh Model Engine Co., *Pittsburgh, Pa.,* (mail) 5845 Marlborough Street.

CARMAN, G. B. (M) chief engineer, Forest City Machine & Forge Co., 5101 Lakeside Avenue, *Cleveland, Ohio.*

CARY, JOSEPH B. (M) operating manager, Air Reduction Sales Co., *New York City,* (mail) Holley Hotel, 36 Washington Square.

CASPAR, CHARLES H. (A) Room 411, Denckla Building, *Philadelphia, Pa.*

CHANDLER, A. D. (M) sales engineer, Wilcox-Bennett carbureter Co., *Minneapolis, Minn.* (mail) 1030 Marshall Street Northeast.

CHAYNE, CHARLES A. (J) instructor, mechanical engineering department, Massachusettts Institute of Technology, Cambridge, Mass. (mail) 406 Marlborough Street, *Boston, Mass.*

CLOCK, FRED A. (M) chief engineer, Watson Products Corporation, *Canastota, N. Y.* (mail) 411 South Peterboro Street.

COLEMAN, THOMAS E. (M) vice-president, Madison-Kipp Corporation, *Madison, Wis.*

CORSE, WILLIAM MALCOLM (M) general manager, Monel Metal Products Corporation, Oak Street, *Bayonne, N. J.*

CRANZ, JAMES M. (M) assistant general manager, Hewitt Rubber Co., 240 Kensington Avenue, *Buffalo, N. Y.*

CRAWFORD, JOHN D. (J) Wellman-Seaver-Morgan Co., *Cleveland, Ohio.*

DANIELS, EUGENE T. (A) general manager, Master Primer Co., 34 East Larned Street, *Detroit, Mich.*

DAVIES, THOMAS B. (A) district sales manager, Central Steel Co., Massillon, Ohio. (mail) 621 University Block, *Syracuse, N. Y.*

DAVIDSON, VERGIL ALVIN (A) sales manager, Cincinnati Ball Crank Co., *Cincinnati, Ohio.* (mail) 2581 Madison Road.

DEADY, EMMETT F. (J) student department, Four Drive Tractor Co., (mail) P. O. Box 233, *Big Rapids, Mich.*

DELONG, J. E. (M) assistant engineer, Indiana Truck Corporation, *Marion, Ind.*

DENNEEN, F. S. (M) manager, motor truck division, Grant Motor Car Corporation, *Cleveland, Ohio,* (mail) 9716 North Boulevard.

DEVOR, DONALD SMITH (M) works manager, Willys Corporation, Newark Avenue, *Elizabeth, N. J.*

DONNER, WILLIAM H. (M) aeronautical engineer, Naval Aircraft Factory, Philadelphia, Pa. (mail) P. O. Box 134, *Yeadon, Delaware County, Pa.*

DRUAR, F. J. (M) chief engineer, Standard Motor Truck Co., *Detroit, Mich.* (mail) 1782 East Grand Boulevard.

EASTERLING, KNOX (A) district representative, Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. (mail) 1003 City Trust Building, *Indianapolis, Ind.*

ENGEL, F. J. C. (M) mechanical engineer, Detroit Gear & Machine Co., *Detroit, Mich.,* (mail) 577 Montclair Avenue.

EWART, ELLIOTT S. (J) checker, Denby Motor Truck Co., *Detroit, Mich.* (mail) 556 St. Clair Avenue.

FENLEY, WILLIAM H. (A) sales engineer, Kerite Insulated Wire & Cable Co., 709 Peoples Gas Building, *Chicago, Ill.*

FERNSTRUM, F. O. (J.) draftsman, Gray Motor Co., *Detroit, Mich.* (mail) 717 Lenox Avenue.

FITZGIBBONS, A. J. (A) traveling salesman, Merchant & Evans Co., Philadelphia, Pa. (mail) Genesee Hotel, *Buffalo, N. Y.*

FOX, JOHN FUTHEY (M) draftsman, machinery division, New York Navy Yard, Brooklyn, N. Y., (mail) 2567 Sedgwick Avenue, *New York City.*

FRIEDLY, DONALD C. (J) chassis layout draftsman, engine department, Winton Automobile Co., *Lakewood, Ohio.* (mail) 1353 Mathews Avenue.

FYKE, FRANK C. (J) in charge of testing laboratory, Standard Oil Co., *Elizabeth, N. J.* (mail) 534 Adams Avenue.

GAGE, MAJOR JOHN N. (A) city motor transport office, Motor Transport Corps, *Chicago, Ill.,* (mail) 230 East Ohio St.

GIBBS, CARL C. (A) sales agent, Cleveland plant, National Malleable Castings Co., *Cleveland, Ohio.*

GORLIN, SOL. (J) assistant engineer, Samuel Gorlin & Sons, 105 Orient Avenue, *Jersey City, N. J.*

GRAHAM, JAMES (A) lubrication engineer, Universal Lubricating Co., *Cleveland, Ohio.* (mail) 124 East 156th Street.

GUY, SIDNEY SLATER (F M) managing director, Guy Motors, Ltd., Fallings Park, *Wolverhampton, England.*

HACK, G. A. (J) assistant metallurgist, Champion Ignition Co., *Flint, Mich.* (mail) 422 Warren Street.

HANCH, C. C. (M) general manager, Maxwell Motor Co., Inc., *Detroit, Mich.*

HASTINGS, ROGER W. (M) chief engineer, Parker Axle & Products Corporation, 19 West Forty-fourth Street, *New York City.*

HENSHAW, TRESCOTT A. (A) production department, Stewart Motor Corporation, *Buffalo, N. Y.,* (mail) 43 Ada Place.

HIGGINS, HOWARD R. (J) Page Co., *Chicago, Ill.,* (mail) 4959 Michigan Avenue.

HILDRETH, NED E. (M) superintendent, Cushman Motor Works, *Lincoln, Neb.* (mail) 1945 South Twenty-sixth Street.

HIPSELY, WILLIAM BURTON (F M) managing director, Hipsely Waddell, Ltd., *Sydney, N. S. W., Australia.* (mail) 35 Palmer Street.

HUCK, LOUIS C. (J) automotive engineer, 755 Waveland Avenue, *Chicago, Ill.*

HUGHES, H. F. (M) sales manager, E. W. Bliss Co., *Brooklyn, N. Y.,* (mail) 540 Sixteenth Street.

JANICKI, JOHN (M) chief engineer, Ursus Motor Co., *Chicago, Ill.* (mail) 3815 West Congress Street.

JERNBERG, C. RICHARD (A) superintendent, Standard Forgings Co., *Indiana Harbor, Ind.*

JOHNSON, JOHN THOMAS (M) works manager, Portage Rubber Co., *Barberton, Ohio.*

JOHNSTON, THOMAS HENRY (A) mechanical superintendent, Beach Motors, Ltd., 186 Albert Street, *Ottawa, Ont., Canada.*

JORDAN, WILLIAM ALLEN (A) vice-president, United Motors Service, Inc., 782 Woodward Avenue, *Detroit, Mich.*

KELLEY, EDWARD WILLIS (J) designing draftsman, Electric Wheel Co., *Quincy, Ill.,* (mail) 220 North Fourteenth Street.

KENT, P. J. (M) electrical engineer, Studebaker Corporation, *Detroit, Mich.,* (mail) 1297 John R. Street.

KERN, ROY S. (A) automotive instructor, Vocational High School, *Virginia, Minn.*

KESSLER, E. HARRY (J) assistant planning engineer, Standard Parts Co., Cleveland, Ohio, (mail) 146 Baltimore Street, *Dayton, Ohio.*

KINNARD, LUTHER J. (E S) student, Purdue University, Lafayette, Ind. (mail) 156 North Grant Street, *West Lafayette, Ind.*

KIRCHNER, THEODORE E. (J) draftsman, Cleveland Automobile Co., *Cleveland, Ohio.* (mail) 3263 East Fifty-fifth Street.

KLINGER, GEORGE WALTER (J) engineer of tests, Vibration Specialty Co., 303 Harrison Building, *Philadelphia, Pa.*

Koelker, Oscar H. (M) assistant chief engineer, L. H. Gilmer Co., *Tacony, Philadelphia, Pa.* (mail) 7037 Edmonds Street.

Lake, Harley W. (M) mechanical engineer, 126 Hill Avenue, *Highland Park, Detroit, Mich.*

Lantz, William M. (J) aeronautic engineering, Naval Aircraft Factory, *Philadelphia, Pa.* (mail) West Branch Y. M. C. A., Fifty-second and Sansom Streets.

Larson, Clifford M. (M) assistant supervising lubricating engineer, Sinclair Refining Co., *Chicago, Ill.* (mail) 7251 Bennett Avenue.

Lefavour, Howard P. (A) principal, automobile school, Providence Young Men's Christian Association, 160 Broad Street, *Providence, R. I.*

McLachlan, John (M) shops supervisor, auto department, New York Telephone Co., New York City, (mail) 30 Ericson Street, *East Elmhurst, N. Y.*

McNay, M. S. (M) sales engineer, Standard Parts Co., Eleventh and Walnut Streets, *Cleveland, Ohio.*

Malone, Allen L. (A) secretary, S K F Industries, Inc., 165 Broadway, *New York City.*

May, Richard B. (M) electrical engineer, Dayton Engineering Laboratories Co., *Dayton, Ohio.*

Mench, Eugene L., Jr. (J) engineer, Mutual Truck Co., *Sullivan, Ind.*

Morgan, Clinton E. (M) assistant general manager, Brooklyn City Railroad Co., 168 Montague Street, *Brooklyn, N. Y.*

Murray, Harry E. (J) assistant engineer, Bessemer Motor Truck Co., *Grove City, Pa.*, (mail) General Delivery.

Nein, Charles L. (M) designer, International Motor Co., New York City. (mail) 170 Gleane Street, *Elmhurst, N. Y.*

Niemann, Richard Thorne (A) salesman, Autocar Sale & Service Co., *New York City*, (mail) 2222 University Avenue.

Northwestern Malleable Iron Co. (Aff) 756 Park Street, *Milwaukee, Wis.* Representatives: Frederick L. Sivyer, president; William C. McMahon, vice-president.

Norton, S. V. (A) representing second vice-president in charge of sales, B. F. Goodrich Rubber Co., *Akron, Ohio.*

Olsen, R. Lehman (M) mechanical engineer, Fergus Motors of America, *Newark, N. J.* (mail) 37 Hillside Avenue.

Osmun, Major R. A. (S M) Motor Transport Corps, *Washington*, (mail) 3923 Livingston Avenue, Northwest.

Ottinger, Leon (A) inventor, (mail) 31 Nassau Street, *New York City.*

Palmer, R. A. (M) president, Collier Motor Truck Co., *Bellevue, Ohio.*

Parson, Lieut. Ralph Monroe (J) supervising instructor, engine maintenance force, U. S. Naval Training Station, *Great Lakes, Ill.* (mail) Aviation Mechanics School.

Patrick, I. (M) assistant chief engineer, E. W. Bliss Co., *Brooklyn, N. Y.*, (mail) P. O. Box 235.

Patterson, S. J. (A) Board of Education, *Detroit, Mich.*, (mail) 617 McClellan Avenue.

Pironneau, Emmanuel (A) consulting engineer, 1779 Broadway, *New York City.*

Pogue, Joseph E. (M) director, department of economic research, Sinclair Refining Co., 111 West Washington Street, *Chicago, Ill.*

Pope, Col. Francis H. (S M) Office of the Chief of the Motor Transport Corps, Seventh and B Streets, *Washington.*

Quigley, George E. (M) 323 Ford Building, *Detroit, Mich.*

Ralston, James M. (J) *Allenhurst, N. J.*

Reader, Allan W. (M) assistant chief draftsman, Willys-Overland Co., *Toledo, Ohio.* (mail) 517 Highland Court.

Rhinelander, Philip II., (J) 27 William Street, *New York City.*

Riblet, Royal Newton (A) vice-president and assistant manager, Riblet Tramway Co., *Spokane, Wash.* (mail) 27 West Augusta Avenue.

Roberts, S. M. (A) vice-president, C. A. Roberts Co., 30 East Woodbridge Street, *Detroit, Mich.*

Schell, Arthur I. (J) engineering department, Bethlehem Motors Corporation, *Pottstown, Pa.*, (mail) R. F. D. No. 1.

Scherbau, Arthur, Jr. (J) tool and die maker, Eisemann Magneto Co., *Brooklyn, N. Y.*, (mail) 371 Third Street.

Schlachter, Henry (J) vice-president, Automotive Educational Bureau, 1203 Farnam Street, *Omaha, Neb.*

Shlick, Paul F. (J) draftsman, Minneapolis Steel & Machinery Co., Minneapolis, Minn. (mail) 825 Goodrich Avenue, *St. Paul, Minn.*

Sedley-Brown, G. C. (A) salesman, Colt Stratton, Inc., *New York City*, (mail) 555 West 186th Street.

Segner, Charles B. (M) vice-president and general manager, Domestic Engine & Pump Co., *Shippensburg, Pa.*

Seymour, B. F. (A) engineering department, Midwest Engine Co.; Stopshok Wheel Co., *Indianapolis, Ind.*, (mail) 3515 North Pennsylvania Street.

Singer, Charles A., Jr. (M) export manager and assistant in production, General Ordnance Co., 512 Fifth Avenue, *New York City.*

Singer, Maurice A. (J) draftsman, International Motor Co., New York City. (mail) 764 St. Johns Place, *Brooklyn, N. Y.*

Slonek, Frank G. (M) chief engineer, R. M. Hvid Co., 803 First National Bank Building, *Chicago, Ill.*

Snyder, Carl J. (J) tool engineer, Lincoln Motor Co., *Detroit, Mich.* (mail) 174 Vicksburg Avenue.

Stamm, A. C. (A) sales engineer, Raybestos Co., Bridgeport, Conn., (mail) 484 Walnut Street, *Elizabeth, N. J.*

Steeg, Benjamin H. (M) layout draftsman, Premier Motor Corporation, *Indianapolis, Ind.*, (mail) 340 North Arsenal Avenue.

Stoll, L. F. (A) branch manager, Class Journal Co., 823 Widener Building, *Philadelphia, Pa.*

Swarthout, Gerald E. (M) chief engineer, Stearns Mfg. Co., *Ludington, Mich.* (mail) 202 North Gaylord Avenue.

Thornhill, W. H. T. (M) steel specialist, Midvale Steel & Ordnance Co.; Cambria Steel Co., *Philadelphia, Pa.* (mail) 328 West Seymour Street.

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